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Preface

We would like to present, with great pleasure, the inaugural volume-8, Issue-11, November 2022, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

Environmental Research:

Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

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Soil Science	Plant Science
Animal Science	Agricultural Economics
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Sustainable Natural Resource Utilisation	Management of the Environment
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Natural Resources	Basic Horticulture
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Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
Pulse Crops: Peas (all types), field beans, faba beans, lentils, soybeans, peanuts and chickpeas.	Hay and Silage (Forage crop) Production
Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
Tree Nut crops: Hazlenuts. walnuts, almonds, cashews, pecans	Berry crops: strawberries, blueberries, raspberries
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Dairy Sheep	Water Buffalo
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The Advantages of Wheat's Biological Ways of Fighting against Endophit Fungus

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Abstract— *The article examines the effect of endophytic fungi on wheat germination. It was observed that when the seeds of Trichoderma viride and Fusarium oxusporum mixed with the soil at the roots, seed germination and vegetation of the plants ceased. The study found that the fungus Trichoderma viride was effective against soil pathogens and that high yields could be obtained from crops if this fungus was used as a fertilizer against soil pathogens*.

Keywords— Trichoderma, Fusarium, soil, wheat, fungus, antagonist.

I. INTRODUCTION

The content of floristic biocioses contain wide range of systometic categories that are situated in Centeral Asia's teritories.Desertifications salted yards and antropogens factors which are occuring in these places are effecting negatively for demolishing types of plants . As three parts of our republic is desert and half desert, climate changes ,factors of antropogen's deterrent affects are breaking ecological systems.Such as, our natural mazies have been privating for farming or pheasonning, cows sheep are feed and their numbers enhancing, saksavul ,juzg'un, teresken, chagon, shuvoq, yantoqs are cutting for woods, excavations, industry, and precious and useful substances are being taken from ground all of them impact erodicating of fungus.

The things that can effect detrimentally for plants are: radical declininf of temperature, becoming in a high temprature in a long period, cold weather in early spring and summer, late autumn, acid rain, dright, desertifications and salty yards ate creating abiotic stress condition. As a result, they are being main reasons of the lack energy or immune, condition of paranekros, the changes of evolving, some ailments and fading of plants. In the researches we learnt wheat grain as well as useful and patogen funguses through polishing artificially their growth and developments in the extremal atmosphere.

II. MATERIAL AND METHOD

2.1 The methods of investigation

The most interesting desease is fusarois plants proccess among village vegetables, however, the most difficult to study as well.To find its types and characteristics of morphologics are basic obstacle of learning them in our country.The most fundamental thing is Fusarium fungus identifiers (Snyder, Hansen, 1954, Gerlach, Nirenberg. 1982 Leslie 2001) are not available or (Wollenveber, Reinking, 1935, Rayllo, 1940 Bilay 1977, Booth 1977 Leslie 2006) their amount declining so it creats to pick up them

In Uzbekistan scientists have been researching them more than 70 years

Fungus that are in the Fusarium group can be come acrossed easyly in our countries grounds soil plants air and water. They live in the plants rizosferas and make harm to wild grasses, plants, insects, nematodas. They participate proccess of origining of soil in extremal condition of our country, they distribute their portion to the save food reservation chain in modirate condition, demolishing rest of food, sytezing organic and biologic active substances. Litvinov (1969) style is used to learning illnesses of Fusarioz that separate micraorganizms from soil and identificating selected fungus spices V.I.Bilay (1977) identifiers were utilized.

2.2 Thr results of investigations

Researches are made over mainly models of soil and plants that were brought from Tashkent regions wheat fields.Wheat grains are growen after polished artificiallt with fungus from Trichoderma and Fusarium groups having been sorted out real culturals. Experiences demonstrate primary results as follow. There is distinct difference in progressing seeds which is polished with Trichoderma viride and Fusarium oxusporum.

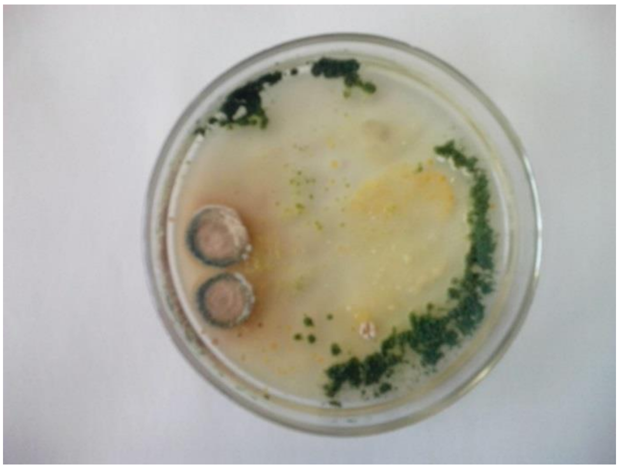

FIGURE 1: Fungi belonging to the category Trichoderma and Fusarium isolated from the soil

FIGURE 2: Fungi belonging to the category Trichoderma and Fusarium isolated from the soil

FIGURE 3: Wheat plant, cultivated by processing with fungi belonging to the category of Trichoderma and Fusarium

FIGURE 4: Wheat plant, cultivated by processing with fungi belonging to the category of Trichoderma and Fusarium

FIGURE 5: Wheat plant, cultivated by processing with fungi belonging to the category of Trichoderma and Fusarium

FIGURE 6: Wheat plant, cultivated by processing with fungi belonging to the category of Trichoderma and Fusarium

FIGURE 7: Plants infected with Fusarium oxysporum fungus. The plant died before the end of vegetation

FIGURE 8: In the control variant (unprocessed), 5 spike was formed and 1 spike was formed in one plant, which was artificially damaged by Fusarium oxysporum fungus.

When wheat grow with Trichoderma and Fusarium oxysporum fangus with polishing outer markes did not noticed. When plant was observed by vegetation, Trichoderma fangus option was successful whereas fusarium oxysporum was unsuccessful.Beforehand wheat ripes all graind and their heaviness everything took into account.

The fruitfulness degree's decreasing in the ill plants.

2.3 Decline in productivity in diseased plants

No.	Options	1 the formation of a spike in the bush plant (On account of 1 m2)	1000 PCs grain weight
1	Trichoderma viride	7	41
2	Fusarium oxysporum	3	29
3	Control variant (unprocessed)	5	35

III. CONCLUSION

According to tabular tested Trichoderma viride fungus proved our trust with less ailment impacts on plants and harvest or results rocketed dramatically. Patogen fungus Fusarium oxysporum option raise sumptoms of deseases. Moreover, they provoked only one wheat and a stem.

On balance, Trichoderma viride sort fungus possesses more antogonistic trait than Fuzarium oxysporum patogen. It was proven in subsequent experimentation. If we apply Trichoderma viride fungus againist wheat's fusarios ailments as biogical priporats we will achieve alarming rate of harvests.

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Effect of Chemical Weed Control on Soil Bio-Chemical Indices- A Review

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***Abstract*—** *The assessment and monitoring of soil life and soil health can be used to develop more sustainable and productive farming systems. Hence, the consequence of herbicide application on soil health is always a concern for the research community. In view of this, the findings available from India in respect to the impact of herbicides on the non-target organisms and important soil bio-chemical processes are reviewed in this paper. There is great variation among the reports showing short term transient depressing to non-inhibitory or even stimulatory effects of herbicides on total soil microbial count and different soil bio-chemical indices. The impact differed depending upon the soil type, experimental conditions, herbicide in question and its dose, and the sensitivity of the non-target species or strains. No severe ill effect on soil flora, soil bio-chemical indices and soil fauna has been observed so far at recommended dose of herbicide under field conditions. However, the available information is based on the short term experiments and there is need to develop data base on long-term field application basis. The paper concludes with some suggested areas for future research requiring urgent attention.*

Keywords*— Actinomycetes, Ammonification, Bacteria, Earthworms, Fungi, Herbicides, India, Nematodes, Nitrification, Nitrogen fixation, Soil enzymes.

I. INTRODUCTION

Soils contain microorganisms viz. bacteria, fungi, yeasts, photosynthetic organisms including algae and macroorganisms such as protozoa, nematodes, mites, springtails, spiders, insects and earthworms. The functions of this complex array of biota are diverse, and include residue decomposition, nutrient storage and release, soil structure and stability, resistance against disease and degradation or immobilisation of soil pollutants. A minimum of species is necessary to carry out essential tasks. It is believed that high biodiversity leads to a higher soil functional stability and thereby, a greater capacity to recover from perturbation and maintaining environmental sustainability.

Weed control in agricultural and non-agricultural lands is rapidly shifting towards chemical methods because of its time, labour and cost advantages. Although herbicides are meant for plants, possibility of a direct effect on other organisms can not be ruled out as a number of basic and universal biochemical processes essential for all forms of life are alike. Direct impacts on sensitive organisms can occur when the chemical reaches the soil due to targeted deposition of pre-emergent herbicides, or through unintentional deposition from spray and spray drift, dripping from plant material, and contaminated plant material falling to the soil.

A decrease in the population of sensitive species may cause an increase in the population of resistant soil microorganisms due to relatively lesser competition. Thus, their application may have impacts on organisms that benefit the wider agro-ecosystem. Such concerns from the research community and general population were well documented in June 1992 at the United Nations Conference on the Environment and Development (UNCED) in Rio de Janeiro, which is referred to as the Convention on Biological Diversity.

In field conditions, herbicides may also greatly influence soil biota populations indirectly by their effects on vegetation which provide habitat and food for many of them. The soil organisms may respond differentially due to the changes in vegetation rather than to direct herbicide effect (Grossbard and Davies 1976, Haugland 1994). Influence of herbicides on soil biota population and agriculturally important soil bio-chemical processes have been reviewed in this paper in light of the findings reported from India.

II. EFFECT OF HERBICIDES ON SOIL MICROFLORA

The total microbial count is the direct measurement of qualitative change appearing after herbicide treatments. Highly contrasting reports are available in the literature in respect to the side effect of herbicides on soil micro-flora. The observations varied from adverse to no effect or even stimulatory effect on microbial growth after herbicide application. Reports indicate the adverse effect of herbicides on selected species of microorganisms in pure culture and many a times at the higher concentration level that is unlikely to occur in the actual field condition at recommended rates of application. No serious or prolonged effect of herbicides on total count of soil microflora was reported. No adverse effect of propanil, nitrofen, prometryne, 2,4-D, bentazon and butachlor application at recommended rates on soil populations of bacteria, fungi and actinomycetes was observed in rice in West Bengal (Mukhopadhyay 1980). Raut et al. (1997) observed that except for a slight initial suppressing effect, butachlor stimulated the microbial population of rice rhizosphere in a Delhi soil. Similarly, at field rate, a short term transient or stimulatory effect of propanil, butachlor, molinate and nitrofen on microbial population in transplanted rice soil was reported by Shetty (1977). Pendimethalin steadily increased the total population of bacteria, fungi and actinomycetes in soil under cotton after a short lag phase during the crop growth period. However, after harvest the soil microorganisms were affected by the pendimethalin residue in soil (Balasubramanian and Sankaran 2001). Generally in field condition, a short time initial depressive effect is followed by an increase in the total bacterial number to the normal level. This delayed stimulation is caused by the adaptation time of the bacteria. Initial depression could be due to the adverse impact on susceptible strains and subsequent increase in the growth rate of the relatively resistant strains with due course of time. The subsequent increase in bacterial number could also be due to the increase in the environment of nutrients that come from weeds killed by the treatment. It can also be explained by the utilization of the herbicides as substrates by the resistant strains.

The amount of herbicide coming into physical contact is of great importance to side effects. In the field condition most of the herbicides do not penetrate more than few millimeters into the soil. Thus, there is rarely total exposure of soil microorganisms to a biologically active concentration of a herbicide. A change in species composition of soil microorganisms may occur after herbicide application but elimination of a single species is very unlikely because the nature will try to restore the former equilibrium quickly (Greaves and Malkomes 1980). However, herbicide-induced shifts in microbial composition may occur even if diversity indices among treatments remain same (Lupwayi et al. 2004). VAM fungi are beneficial and live in association with plant roots. The dissimilarity in the results obtained with herbicides belonging to the same group of chemicals, or even with the same herbicide makes it more difficult to generalize the effect of herbicides on VAM. A herbicide may inhibit the VA colonization by some individual strains but not by others (Dhen et al. 1990, Dodd and Jeffries 1989), clearly showing the direct impact of herbicide on fungus. Oxyfluorfen reduced VAM colonization and spore production in tomato (Abha Mishra and Mishra 1999). While, 2,4-D enhanced both the percentage of infection and number of mycorrhizal propagules in Sesbania grandiflora and Albizia lebbeck (Kumar et al. 1999). The species or even the cultivar of host plants can influence the impact on the herbicides on VAM. The reduction in VAM colonization and spore production in tomato due to oxyfluorfen application varied among the different tomato cultivars tested (Abha Mishra and Mishra 1999). The herbicides, besides a probable direct chemical effect on VAM, do kill the plants and reduce the living food source of the VAM fungi. This may in turn also influence VAM growth and survival.

III. EFFECT ON IMPORTANT SOIL BIOCHEMICAL PROCESSES

Determination of qualitative changes of the huge populations of thousands of species following herbicide application is impossible. There is no universally accepted indicator till date to study the effect of herbicide on soil microflora. The important biochemical processes from agricultural and environmental perspectives are mostly mediated by a group of microbial species and strains. Since sensitivity to a given herbicide varies greatly among the different microbial species and strains, the information related to the side effect of herbicides on the agriculturally important microbial processes as a whole are of greater significance than the observations about a given species or strains.

IV. MICROBIAL ACTIVITY

Due to the technical and practical limitations, the total count data do not distinguish between inactive microorganisms and those really active in soil. Measurement of the activity of the soil microflora provides indexes of the biological state of the soils and hence the soil fertility. Assessment of the enzymes present in soils offers potential as an integrative index of the soil's biological status. Dehydrogenase activity is generally used as an index of metabolic activity of the microbial population in soil.

Except a slight depression initially, butachlor at field rate was generally non-inhibitory in its effect on dehydrogenase activity in rice on a Vertisol (Rao and Saroja Raman 1998). While an initial stimulation in dehydrogenase activity following fluchloralin, butachlor, oxyfluorfen and 2,4-D application was reported by Shukla (1997). Baruah and Mishra (1986) reported that the herbicides 2,4-D, butachlor or oxyfluorfen at the manufacturer's recommended rates to a paddy soil initially stimulated but subsequently (after 7 days) inhibited dehydrogenase activity. Similarly, diuron at 10-100 ppm stimulated dehydrogenase activity in black, laterite and coastal saline soils of India (Sarawad 1987). Carbon dioxide evolution is another important indicator of overall microbial growth and activity in soil. Stimulation in carbon dioxide evolution was recorded due to the application of 2,4-D, butachlor or oxyfluorfen at the manufacturer's recommended rates to a paddy soil (Baruah and Mishra 1986). No adverse effect of butachlor application to rice soil was also reported by Mukhopadhyay (1980). Nitrofen at 100 times the normal rate increased bacterial numbers, dehydrogenase activity and respiration of black clay and red sandy soils (Kale and Raghu 1989). Application of dinitroaniline herbicide pendimethalin significantly inhibited the soil respiratory activities and dehydrogenase enzyme in the rhizosphere of wheat (Shetty and Magu 1997). The extent of inhibitory effect of herbicide on soil dehydrogenase activity and short-term respiration depended on soil type, plant growth and sampling time (Malkomes 1988).

V. AMMONIFICATION

Ammonification of organic form of nitrogen is carried out by wide groups of soil micro-organisms. In an incubation study simulating the flooded condition, Shukla and Mishra (1997) observed that addition of butachlor at 6 mg/kg dose did not have any remarkable effect on ammonification of urea. No significant effect of fluchloralin, butachlor, oxyfluorfen and 2,4-D application on urease activity was observed in a sandy loam soil (Shukla 1997). Similarly, diuron did not inhibit ammonification in black, laterite and coastal saline soils of India even when applied at 100 mg/kg rate (Sarawad 1987). The effect of herbicide may also vary depending upon the soil and environmental factors. The field rate of 2,4-D stimulated ammonification in red sandy clay loam soil but there was no significant effect in black cotton clay soils. While at 5 times of field rate, 2,4-D depressed ammonification in both soils (Deshmukh and Shrikhande 1975).

VI. NITRIFICATION

Unlike ammonification process nitrification is carried out by a very small group of soil bacteria, mainly Nitrosomonas and Nitrobacter. Hence, any probable impact of herbicides on this group of bacteria is of great concern from soil fertility point of view. Moreover, both Nitrosomonas and Nitrobacter are compulsorily needed to complete the oxidation of ammonium–N to nitrate–N, the most preferred form of N for plants. In a laboratory studies, herbicides at field rates generally showed a temporary depressing effect on nitrification that recovered within a short period of time and nitrification proceeds as normal. No marked effect on nitrification of NH4 -N at pH 6.8, but a slight depression at pH 4.9 at 30o C was recorded due to addition of butachlor in soil under laboratory condition (Shukla and Mishra 1997). However in the actual field condition, application of butachlor at 2 kg/ha significantly augmented the availability of mineral N, i.e. exchangeable NH+ 4 and soluble NO3 , in the rhizosphere soil of rice (Debnath et al. 2002a). This showed that there was acceleration of both ammonification and nitrification by rhizosphere microflora resulting in higher release of mineral nitrogen in soil. Diuron at 10-100 mg/ kg, inhibited nitrification in black, laterite and coastal saline soils of India; the inhibitory effect increased with increasing pesticide concentration (Sarawad 1987). Hardly any report is available about any intense adverse effect of herbicides on nitrification in the field situation. Reports available so far indicate that herbicides are generally not harmful on nitrification, rather beneficial at times. Nitrification process was stimulated by 2,4-D-sodium for 2 weeks in a black cotton clay soil but for 1 week in a red sandy clay loam soil; whereas, no stimulation in nitrification was noticed in case of 2,4-D-ester (Deshmukh and Shrikhande 1975).

VII. DENITRIFICATION

It is an important component of soil nitrogen cycle and in Indian context, where available soil N is a constraint for crop growth, it may be considered as a deleterious soil biochemical process from soil fertility point of view. The impact of the herbicides on the growth and activity of the microorganisms related to the denitrification process under Indian agro-climatic situation is being overlooked by the research community. There is severe lack of information in this area so far and it requires attention especially in light of the reports from elsewhere (e.g. Tu 1996, Tenuta and Beauchamp 1996) indicating the stimulatory effect of several herbicides on the denitrification process.

VIII. NITROGEN FIXATION

Nitrogen fixation by symbiotic organisms associated with legumes is of immense importance throughout the world. The adverse impact of herbicides on survival and growth of Rhizobia is observed beyond a threshold concentration which depends on the type and concentration K.K. Barman and Jay G. Varshney 13 of herbicide used and also on the species/strain of the Rhizobia studied. Mostly the adverse impact is recorded when the herbicide is added in excess of field recommended rates. At field rates of addition most herbicides are unlikely to have much effect on rhizobial growth. Nitrofen stimulated Rhizobium in pure culture (Kale and Raghu 1989). Singh et al. (1978) reported that few strains of Rhizobium leguminosarum were more resistant to butachlor than few strains of cowpea Rhizobium or R. japonicum and Rhizobium tolerated higher concentrations of butachlor than the blue-green algae. However, compared to mechanical or manual weeding, a decrease in nodulation in legumes due to herbicide application is often reported in the literature. Lentil showed adverse impact to the application of oxyfluorfen, linuron, metribuzin, and oxadiazon in terms of nodulation and nitrogenase activity (Sandhu 1991). Pendimethalin and fluchloralin also showed toxic effect to the nodulation in lentil compared to the hand weeding treatment (Yadav et al. 1990). Similarly, a decrease in the nodulation and nitrogenase activity in pea was caused by methabenzthiazuron, linuron and pendimethalin application (Gurcharan Singh et al. 1994). However, the toxic effect of herbicides on nodulation generally disappears with time. For example, fluchloralin, metribuzin and oxadiazon showed toxic effect on soybean nodulation at 25 DAS, but the adverse effect disappeared by 50 DAS (Jain et al. 1990). No harmful effect of imazethapyr on nodulation in soybean was observed by Billore et al. (1999). Similarly, at field rate of application to soybean, fluchloralin in combination with the rhizobial culture and (or) plant growth promoting rhizobacteria showed better nodulation and nitrogenase activity compared to the inoculated but no pesticide treatment and the uninoculated control (Murali Gopal 2002). It may be noted that herbicides may affect legume-Rhizobium symbiosis in different ways by reducing survival or growth of Rhizobia by inhibiting the nodulation process by causing abnormalities in plant growth and metabolism; or by influencing nitrogen fixation.

A number of reports indicate the adverse impact of herbicides under laboratory conditions, however no serious effect of herbicide application at recommended dose on free living N-fixers has been reported under field conditions. Toxic effect of butachlor (at 2 µg/g) on Azospirillum population in alluvial and acid sulphate saline Pokkali soils was reported by Jena et al. (1987). However, Rai (1985) isolated butachlor-resistant strains of Azospirillum brasilense from roots of rice. Patnaik and Rao (1994) reported about a substantial stimulation in nitrogenase activity of Azospirillum isolated from 2,4-D amended rice rhizosphere soils, following exposure to 2,4-D at concentration up to 5 ppm under normal fixing conditions. Addition of ammonium-N significantly reduced its nitrogenase activity, but the toxic effects of combined nitrogen were alleviated in the presence of 2,4-D. An increase in root-associated aerobic and microaerophilic N2 fixing bacteria and stimulation in nitrogen fixation activity of young barley seedlings by pendimethalin at field rate in a neutral alluvial loam soil was reported by Jayanta Saha et al. (1991). The stimulatory response, however, declined with age of seedlings and higher concentration of the herbicide. Azotobacter vinelandii and Azospirillum lipoferum isolated by these workers from the pendimethalin-treated barley rhizosphere showed in vitro tolerance to high concentrations of the herbicide in N-free media; and the Azotobacter isolate utilized pendimethalin as a C source to fix N2 in pure culture. The property of pendimethalin utilization for N2 fixation was also exhibited by Azotobacter chroococcum (Jayanta Saha et al. 1991). It was observed in dark laboratory conditions that the soil bacterium A. chroococcum can effectively degrade pendimethalin (Kole et al. 1994). Unlike the total population of bacteria and fungi, an increase in actinomycete and Azotobacter population by pendimethalin at 1.5 ppm concentration was recorded in a sandy loam soil (Shetty and Magu 1996). A. chroococcum also showed the ability to utilize the herbicide 2,4-D and its degradation products, p-chlorophenoxyacetic acid and p-chlorophenol as sole carbon source, and showed an increase in oxygen uptake and stimulation in nitrogenase activity in presence of the chloroaromatics (Balajee and Mahadevan 1990). The nitrogenase activity in four A. chroococcum strains isolated from agricultural soil, enriched with 2,4-D, remained unaffected up to 50 ppm of 2,4-D in liquid medium (Gahlot and Narula 1996). Seed inoculation with A. chroococcum increased grain and straw yield, and also reduced the phytotoxic effects of 2,4-D on wheat on a sandy loam soil (Ajit Singh et al. 1997). No adverse effect of diclofopmethyl application up to twice the recommended dose on the Azotobacter population was noticed in the soil of a wheat field at harvest (Singh et al. 1996). While, nitrofen inhibited A. chroococcum in pure culture (Kale and Raghu 1989). Application of butachlor at 2 kg/ha, significantly augmented the proliferation of aerobic non-symbiotic N2 fixing bacteria and hence the non-symbiotic N2 fixing capacity of the rhizosphere soil of rice (Debnath et al. 2002a).

Under laboratory condition, application of butachlor reduced populations of anaerobic nitrogen fixers in a nonflooded alluvial soil, but stimulated its population in an acid sulphate saline Pokkali soil under a similar water regime (Jena et al. 1987). However, in submerged condition, butachlor stimulated nitrogen fixation in the alluvial, lateritic Impact of herbicides on soil environment 14 and acid sulfate soils (Jena et al. 1990).

Algal growth is sensitive to herbicide application but the sensitivity varies among the different species and also depending on the herbicide. Likhitkar and Tarar (1996) reported that increasing butachlor concentrations gradually reduced the nitrogen fixation by Nostoc commune and N. muscorum but did not retard cyanobacterial activity at the normal recommended field application dose and can safely be used with these cyanobacteria. N. muscorum was more tolerant than N. commune to butachlor. Kashyap and Pandey (1982) reported that butachlor at low concentrations (0.05 µg/ml) had stimulatory effects on Anabaena doliolum, but completely inhibited its growth at 20µg/ml. However, the increased concentration of butachlor did not have any adverse effect on Anabaena sphaerica, rather it accelerated the algal contribution in terms of biomass and nitrogen fixation (Suseela 2001). Low concentrations of butachlor significantly increased heterocyst spacing in Anabaena doliolum. The nitrogenfixing ability of A. doliolum and Nostoc muscorum was not affected by butachlor but was reduced at the higher concentrations (Singh et al. 1978).

IX. DECOMPOSITION OF ORGANIC MATTER:

A favourable effect of glyphosate and 2,4-D on growth and activity of several strains of cellulolytic bacteria, namely, *Cellulomonas, Pseudomonas, Clostridium, Polyangium, Clonothrix, Sporocytophaga, and fungi, Aspergillus syndowii and Fusarium oxysporum*, isolated from tea plantations, was reported by Bora and Bezbaruah (1992). The test strains degraded the various weed litter (e.g. *Cynodon dactylon, Glyceria maxima, and Legurus ovatus*) sprayed with glyphosate and 2,4-D at faster rate than the untreated counterparts. Unlike the herbicides glyphosate and 2,4-D that increased the population of cellulolytic strains, dalapon and paraquat reduced it in the soil of a tea plantation (Balamani Bezbaruah et al. 1995).

X. PHOSPHORUS AVAILABILITY:

Oxyfluorfen has been shown to increase phosphorus availability in rhizosphere soil (Das et al. 2003). Phosphatase [phosphoric monoester hydrolase] activity was increased by fluchloralin, butachlor and oxyfluorfen, but was reduced by 2,4-D (Shukla 1997). Its application significantly augmented the proliferation of phosphatesolubilizing microorganisms in the rhizosphere soil of wetland rice, and there was a significant positive correlation between the population of phosphate solubilizing microorganisms and phosphate solubilizing capacity in the soil (Debnath et al. 2002b). Application of dinitroaniline herbicide pendimethalin significantly inhibited the soil phosphatase enzyme in the rhizosphere of wheat (Shetty and Magu 1997). In vitro alkaline phosphatase activity in Anabaena under glyphosate treatment showed increase in enzyme activity compared with the untreated control (Ravi and Balakumar 1998).

XI. EFFECT ON SOIL FAUNA:

The soil fauna plays an important part in the decomposition of litter in soil, they may indirectly increase aeration and drainage in the soil while feeding on decayed woods, contribute to the formation of humus in association with soil bacteria; and hence considered to be beneficial in relation to the structure and fertility of soil. On the other hand there are some injurious groups of soil fauna, e.g. parasitic nematode.

Nematodes occupy an important place in microscopic life and belong to the soil microfauna group. The interactions of herbicides with nematodes of higher plants are generally noticed. Changes in the incidence of plant diseases may result from the application of herbicides through the effect they have on the pathogen, the host or microorganisms in the environment. Herbicides belonging to different chemical groups were found to increase or decrease nematode diseases of many plants (Trivedi 1988). In a long-term study under tea plantation, Gope and Borthakur (1991) noticed that nematodes (*Helicotylenchus, Meloidogyne, Paratylenchus and Trichodorus spp*.) population was increased by glyphosate, dalapon and simazine, while adversely affected by diuron. Swain et al. (1991) compared the application of bensulfuron-methyl, butachlor, quinclorac, thiobencarb, pretilachlor, pendimethalin, piperophos and 2,4-D at field rates with manual weeding for the control of nematode Hirschmanniella mucronata in rice. Butachlor and pretilachlor were the most toxic and resulted in the lowest nematode populations one month after application. While, application of alachlor and fluchloralin at field rates to soybean increased the soil nematode population in a deep alluvial soil (Mohammed 1987). However the effect of these herbicides varied depending upon the nematode species and the crop growth stages. Alachlor increased Longidorus spp. until crop maturity as well as Aphelenchus and Hoplolaimus during crop branching. Fluchloralin markedly increased the numbers of Tylenchorhynchus spp., especially towards the end of the growing season.

The acute toxicity of butachlor to the earthworm *Drawida willsi* was determined by Smeeta Panda et al. (2002). The 96-hour LC50 values for juvenile, immature and adult earthworms were found to be much higher than the recommended agricultural dose of butachlor. Contrary to this, Panda and Sahu (2004) reported that butachlor was toxic to earthworms at agricultural rates. A decrease in the earthworm population was observed in a rice field K.K. Barman and Jay G. Varshney 15 due to pendimethalin spray or cultural methods of weeding, but there was no difference between the two weed management practices (Mishra et al. 1996). The complete mortality of the earthworm *Eisenia fetida* was seen when directly exposed to atrazine and oxyfluorfen by filter paper, but there was no mortality when the herbicides were applied in soil. Although some physiological and behavioural changes were observed at higher doses, both the herbicides were nontoxic in the soil at normal exposure and were relatively safe for earthworms (Chitra Srivastava 2002).

XII. CONCLUSION:

Herbicides being toxic to plants may exert some kind of impact on other life forms in soil by their direct chemical action and by changing the soil ecosystem as result of changes in vegetation cover. Overall, the experimental results showed that the population of soil microflora are stimulated or depressed by herbicides, depending upon the chemical nature, preparation, its dose, and sampling time and soil type. It is difficult to draw conclusions from such varied results on the counts of the microorganisms of the soil vis-a-vis herbicide application. However, at recommended rate of herbicide application, often a reversible change in the equilibrium of the population of micro-flora and fauna takes place in soil for a short period of time under field conditions.

It may be kept in mind that to effectively evaluate the relative effects of different agricultural practices in the long-term it is necessary to sample until the ecosystem has achieved some degree of equilibrium rather than monitoring only initial cropping cycles (Yeates *et al*. 1999). If herbicide application is to remain a viable practice in sustainable farming systems, evaluation of herbicide effects from repeated and long-term use is essential to ensure optimum nutrient availability and plant growth. However, the literature available so far is based on either laboratory experiments or short-term field experiments. Report on the basis of well-planned long-term field experiment is not available to draw any conclusion regarding the environmental implications of herbicide. Therefore, the steps should urgently be taken to generate data on long-term application basis. Changes in the many vital soil processes become visible in a long term, for example changes in soil organic C content. Some processes show “transition phenomenon”, that is an impact may continue for years without any visible changes in the measured soil characteristics; and after a certain transition time the characteristics change at rapid rate. For example nitrate leaching from grasslands due to mineral nitrogen fertilization did not vary much during the initial years, but after several years it increased suddenly in spite of that the mineral N fertilization remained the same. Feasibility of such “transition phenomenon” in the microbially mediated important soil processes in respect to the soil fertility and productivity should not be ignored, especially in light of the reports showing the differential effect by the different group of microbes, even strains, to a given herbicide. Long-term experiments and data base is needed to fore see such probabilities and to derive suitable remedial measure.

Most of the information generated so far are of superficial in nature and dealt primarily about total counts. There is a dearth of information regarding the herbicide effect on the changes in microbial diversity, nitrification, denitrification, sulfur oxidation, mineralization of plant nutrients, crop residue decomposition and its consequence upon quantitative and qualitative aspect of soil organic matter equilibrium. In depth study in respect to the herbicide effect on biological nitrogen fixation is also meager. Future research is very much warranted in these directions. No serious effort has yet been made to study the dynamics of various groups of soil fauna in the fields receiving herbicide application, and it needs more attention.

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Drip Irrigation System: A Water and Nutrient Conservation Approach to Sustainable Crop Production

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Abstract— *Drip irrigation system is a most efficient and modern technique of irrigation, this method is used in those area where there is a scarcity of water, In this technique generally water and nutrient are allowed to deliver directly to the root zone by controlling the pressurised water through valves of the P.V.C (polyvinyl chloride) drip pipes in such a way that it systematically irrigate the whole field drop by drop directly to the root zone, and saves water up-to 70% as compare to flood irrigation method.*

Keywords— Drip Irrigation, Water Conservation, Nutrient Conservation, Crop Production.

I. INTRODUCTION

Drip irrigation is a modern concept of irrigation in which generally water and nutrients are allowed directly reached to the roots zone drop by drop in the right amount. As the name implies drip irrigation which means irrigation is done by drops of water. It is also known trickle irrigation or a micro-irrigation system.

FIGURE 1: Drip Irrigation System

In this modern era this modern facility of irrigation are generally adapted for irrigation because it is very effective and efficient method of irrigation, as it also have the potential to save enough amount of nutrients and water up-to 70%, by allowing water to deliver systematically directly to the root zone of the plants.

In drip irrigation system, specially designed P.V.C. or Polyvinyl hose pipes having a diameter 13-32 mm are generally used to install this modern irrigation system, through these pipes water are allowed to reach directly to the root zone drop by drop of the plants, and helps the plants to grow un-effectively and efficiently. The main objective of the drip irrigation is to place water directly into the root zone and minimize the evaporation rate.

II. HISTORICAL BACKGROUND

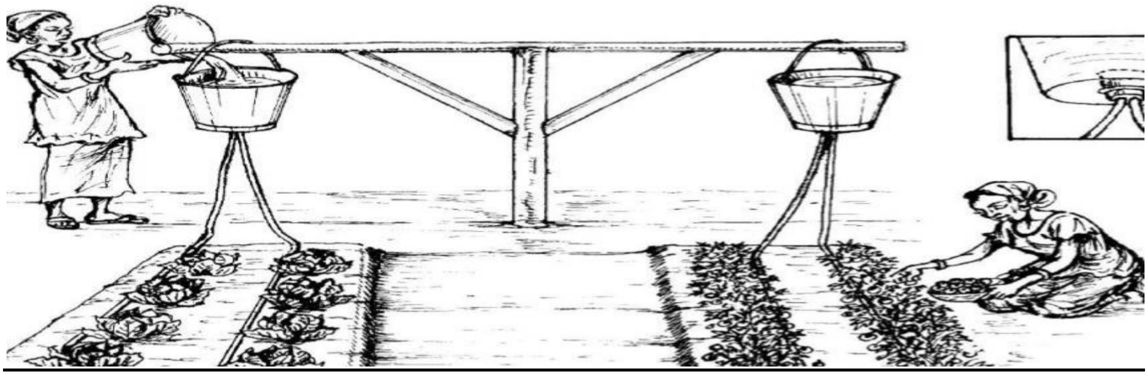

FIGURE 2: Ancient drip irrigation system.

Simcha Blass is known as a father of Drip irrigation system, this great invention has changed the world of agriculture by minimizing the use of water for irrigation and nutrients for development of plants. The very first Drip irrigation experimental system was established in 1959 by Simcha Blass, after 5-10 years he partnered later with Kibbutz Hatzerim in 1964, successfully they both created an irrigation company called Netafim.

This modern concept of irrigation was first adopted by Israel for cultivation, as there is a scarcity of water available in Israel, which is not enough for cultivation, to overcome this problem they adopt Drip irrigation method as this method consume less amount of water and nutrients and give good yield.

III. METHODOLOGY

FIGURE 3: Drip by Drip water reaches to the root zone.

Drip irrigation works by controlling the pressure of the water, which flows from the main water supply lines, tanks or a tube-wells to the drip irrigated pipes. With the help of drip irrigation system the pressurised water that diverts from the main line to the drip irrigated lines are controlled in such a way that drop by drop it irrigate the root zone of each and every individual plant through P.V.C pipes and saves the water in enough quantity and helps the plant to grow efficiently. Drip irrigation system was compiled with modern technology. After the installation it automatically controls the pressure of the water with the help of valves. Suitable pressure is used to irrigate the root zone of the plant accordingly; once the whole field get irrigated through drip system it automatically switched off the system which helps to prevent further loss of water.

IV. WHY DRIP IRRIGATION?

Drip irrigation system help:

- To save optimum amount of water and nutrients.
- It need less labour requirement as compare to other irrigation method.
- It efficiently utilise the water and nutrient with least loss as compare to other system.
- A chance of crop failure reduces.

- Drip irrigation helps to give better output in yielding.
- Less chances of weeds competition with crops.

V. REQUIREMENT TO SET UP DRIP IRRIGATION SYSTEM:

1. **Station Pump** - Takes water from the main source and deliver it into the Drip irrigated pipes with right pressure.
2. **Control valves**- These valves are specially designed to control the pressure and discharge of water in the entire drip irrigated system.
3. **Filtration system**- This system helps to clean the entire water which flow into the drip pipes.
4. **Fertilizer tank**- This tank help to add accordingly measured doze of fertilizer into the water during irrigation.
5. **Mainlines/ Sub-line**- These are specially designed P.V.C or polyvinyl hose lines having a diameter 13-32(mm) which is used to supply water from the control head into the fields.
6. **Emitter** - Emitter device are used to accurately control the discharge of water from the lateral lines to the plants.
7. **Pressure gauge** - In this irrigation system this device is used to measure the pressure of the water which was flow in the entire drip irrigation system.

VI. CROPS SUITABLE FOR DRIP IRRIGATION SYSTEM:

- ***Orchard*** – Grapes, Banana, Pomegranate, Orange, Mango, Lemon, Citrus, Guava, Pineapple, Papaya.
- ***Vegetables***- Tomato, Chilly, Capsicum, Cabbage, Cauliflower, Onion, Okra, Brinjal.
- ***Cash crops***- Sugarcane, Cotton, Strawberry.
- ***Flower***- Rose, Carnation, Gerbera, Orchids, Jasmine.
- ***Plantation***- Tea, Rubber, Coffee, Coconut.
- ***Oil-seeds***- Sunflower, Groundnut.

VII. MERITS:

- Crop grows consistently, healthy with good yield.
- It saves water up-to 70% as compare to traditional method of irrigation.
- It also enhances the yield of crop plants.
- It also minimizes the use of fertilizer doze.
- Cost of labour requirement, intercultural operations, Nutrients application also gets reduced.
- It also helps to enhance the infiltration capacity of the soil.
- Less chance of crop failure.
- Weeds are grown in less percentage.
- Minimize the effect of soil erosion.
- We can use recycled water efficiently.

VIII. DEMERITS:

- Initial investment is comparatively high to install Drip irrigation system.
- Having a high maintenance cost.
- Might be a chance of drip pipes leakage.
- Sometime P.V.C pipes are chocked or blocked.

- Need regular investment for replacing the Drip irrigation system entirely.
- Need high skilled labour to use this irrigation system.
- Solar radiation affects the pipes used in drip irrigation, and shortening their usable life.
- This method of irrigation is not suitable for closely planted crops such as Rice, Wheat etc.
- The establishment of this system is different for each and every crop, so it is also considered as expensive method of irrigation.

IX. CONCLUSION:

Drip irrigation system mainly used in dry-land areas, where there is a scarcity of rainfall and water, like arid and semi-arid region. To overcome this problem farmers have to adopt this modern irrigation technique in dry land areas and have to take a one step towards Drip irrigation system, as this system need limited amount of water to irrigate the whole field drop by drop and also have a potential to conserve 70% of water as compare to flood irrigation.

In my opinion this is the best method of irrigation for dry land areas, all arid and semi arid region farmers have to adopt this method of irrigation for the effective and sustainable production of crops and plants.

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Assessment of Pressurized Irrigation Systems in Hürkuş Public Park at Pursaklar Province of Ankara, Türkiye

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Abstract— *In current study, pressurized irrigation systems using for irrigation of landscape plants in Hürkuş park within Pursaklar district of Ankara were researched. In the study technical characteristics of irrigation systems such as in sprinkler systems sprinkler types, sprinkler arrangement, and discharge, and in drip irrigation system, diameters and lengths of main, sub-main and lateral lines, emitter spacing, and emitter discharges were analyzed. In addition, in both irrigation systems, irrigation numbers and irrigation time consequently seasonal applied water were calculated. In result, seasonal applied water by sprinkler and drip irrigation systems were found as around 1382 mm and 1540 mm, respectively. The applied water was mostly relevant to the atmospheric conditions during plant growing cycles as well as plant characteristics.*

Keywords— Irrigation, Landscape, Sprinkler Irrigation, System Design, Trickle Irrigation.

I. INTRODUCTION

In general landscape plants are planted in parks or other nearby buildings for improvement spiritual comfort of people. Those plants serve as facilitating shading areas for people or animals from sunshine burning impacts, wind breaks and so on.

As known that adequate plant growth can be accomplished under no water stress during whole plant growing cycles. Water stress through the rooting systems for mature plants causes slow drops of leaves and declines in plant growth [1]. Successful irrigation water management has reduced environmental risks and improves the water savings. In the literature review, previous studies have focused on irrigation program of turf grasses in general and almost very little about woody plants [2]. In obtaining nice view in parks, timely irrigation is very important role to play particularly in water shortage ecologies such Ankara province of Türkiye. Due to the plenty advantages, pressurized irrigation systems are getting high popularity in most parts of the Türkiye including middle Anatolia region of Türkiye.

Uses of water saving irrigation technologies and doing regular maintenance-repair works for those irrigation system tools are very efficient ways for water economy [3]. It is possible to save water around 30-60% by using drip irrigation technique [4]. Similarly, Manda et al. [5] mentioned about 50% water and 30% fertilizer savings in drip irrigation by comparison to the surface irrigation methods. Water application in drip irrigation technique over surface irrigation systems was almost 30-70%, and production increment was around 20-90% [6]. Water consumption in urban landscape depends on some factors such as designing of landscape, managerial processes, and environmental characteristics. Thus, productive water use in urban residential purpose is also very important in water resources sustainability [7]. In areas where water shortage is serious problem, drought tolerant plants should be planted instead of water sensitive crops. In case of considering high water consuming crops such as grass, wilting or complete drying could be observed due to the insufficient water application and late irrigation during the crop growth cycles [8]. The most important input in landscape areas is watering particularly arid and semi-arid environments. To accomplish well water management, crop patterns should be organized in accordance of current water supplies in such regions [9]. Correct design of the sprinkler irrigation systems leads to high watering uniformity. There are plenty different design types of such systems, and installation costs as well as water application uniformity are affected from system designs [10]. In addition, effects of environmental variables on plant growth should be well understood for successful management of irrigation systems [4]. In irrigation program, having correct information about evapotranspiration (ETc) is vital important. ETc depends on atmospheric conditions such as temperature, relative humidity, wind speed, altitude, and crop characteristics including crop type, growing cycle, root depth, and leaf properties [11].

Limited studies are present in literatures relevant to assessment of irrigation systems using at landscape areas [12]. Therefore, the aim of the present study is to evaluate the drip or sprinkler irrigation systems as a sample Hürkuş public park within Pursaklar town of Türkiye.

II. MATERIAL AND METHOD

The research was done at Hürkuş Park at Pursaklar town of Ankara, Türkiye (Fig. 1). The town, 950 m above the sea level, is placed on Norhern part of Ankara. The site receives, 416 mm /year, more precipitation than Ankara city center since it is situated on transitional zone of Black Sea region. In general dry environment is prevailing and almost none precipitation has observed at summer period. The rainfall patterns in spring, summer, autumn, and winter are 131 mm, 60 mm, 78 mm, and 167 mm, respectively.

In research, technical properties of pressurized irrigation systems were analyzed. Applied water was determined by using water meter (Fig. 2). In that purpose, seasonal applied water for both sprinkler and drip irrigation systems was calculated as;

$$IW = (Vw/A) \times 1000 \quad (1)$$

Where; IW-Seasonal applied water (mm); Vw-Seasonal applied water (m^3), and A-irrigation area (m^2).

In addition, applicable recommendations were proposed for efficient water management in water shortage Middle Anatolian region of Türkiye.

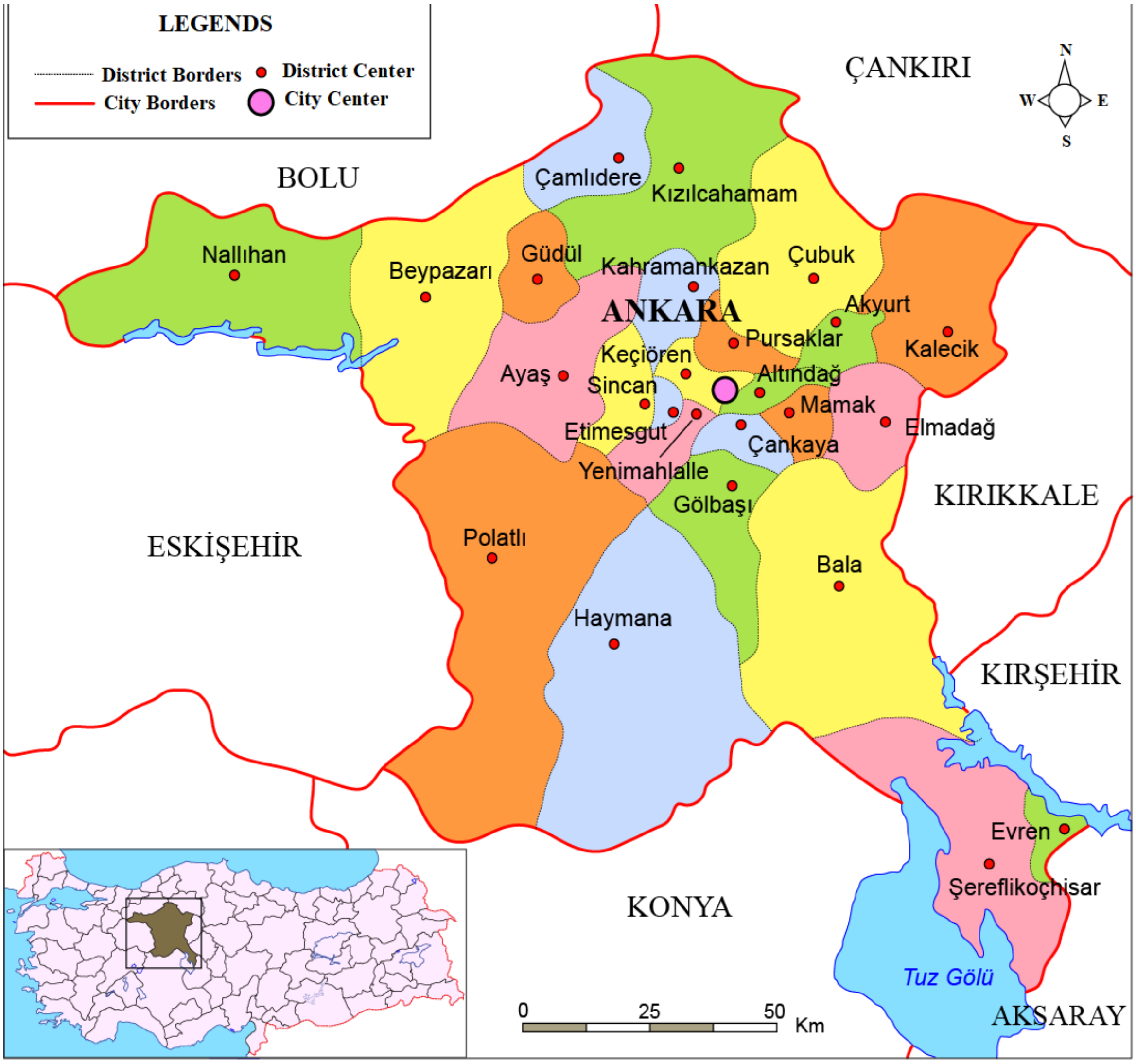

FIGURE 1: Research site (Pursaklar town)

FIGURE 2: Water meter for measuring water flow

III. RESULTS AND DISCUSSIONS

3.1 Characteristics of irrigation systems

3.1.1 Sprinkler irrigation system

The irrigation water was obtained from tank with a capacity of 10 m^3 (*Figure 3*). The irrigation process was performed by automatically. The diameter of main line was 110 mm. The sprinkler arrangement was (5 x 5) m.

As seen Fig. 3, length of the lateral for each irrigation section was 60 m and there were 12 sprinklers on each lateral. In accordance of site observations, water distribution performance of sprinklers was seen as satisfactory.

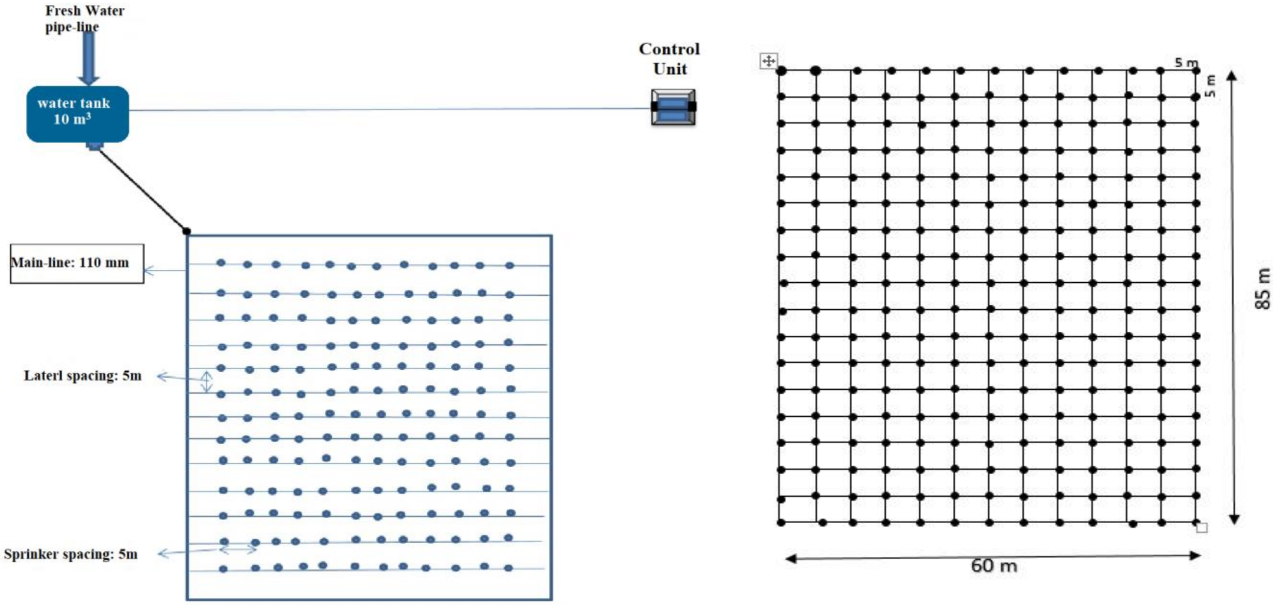

FIGURE 3: Layout of sprinkler irrigation system

3.1.2 Drip irrigation system

Like sprinkler irrigation system, water was taken from tank with a capacity of 10 m^3 in drip irrigation system. The drip system had following components; sub-main line with 63 mm, lateral tubes with 20 mm, 0.80 m lateral spacing and 0.33 m emitter spacing (Fig. 4). In accordance of our measurement, average emitter discharge was found as 3 L/h.

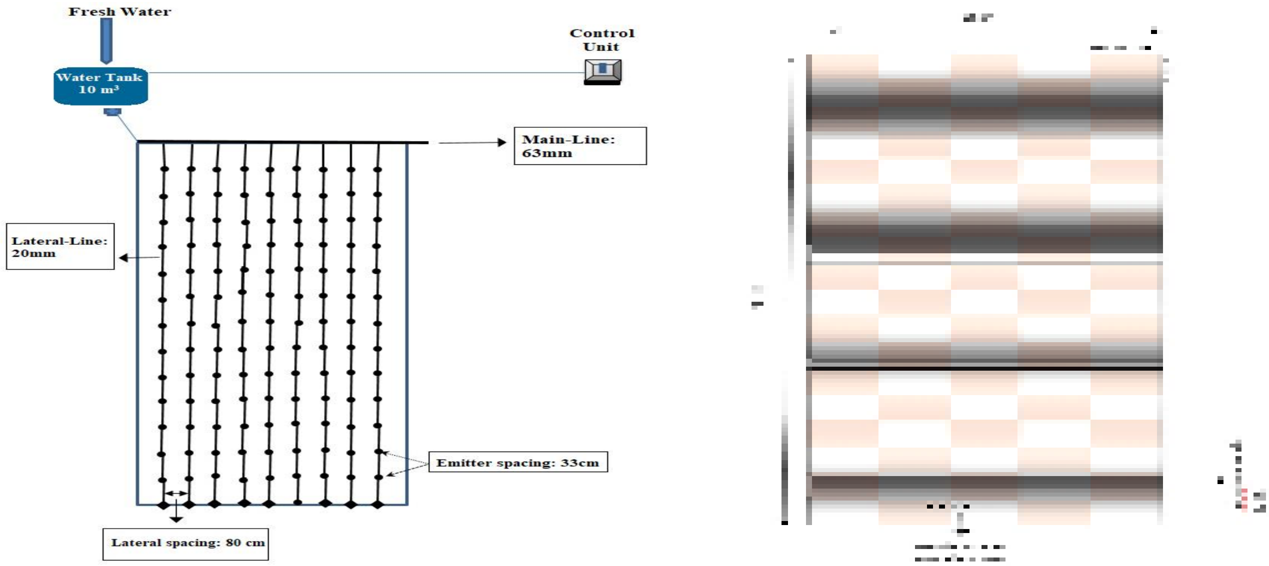

FIGURE 4: Layout of drip irrigation system

3.2 Applied water

3.2.1 Sprinkler irrigation system

Total applied water both the sprinkler and drip irrigation systems were measured as 10516 m^3. The applied water by drip irrigation system was 3466 m^3 so irrigation water application with sprinkler irrigation system was found as 7040 m^3 (10516 m^3- 3466 m^3).

There were 204 sprinklers in system so sprinkler flow rate was 30.55 m^3. Total irrigation time was 135h so sprinkler flow rate was calculated as 0.26 m^3/h (30.55 m^3/135 h).

Sprinkler precipitation rate (Pr) was calculated as 0.010 m/h (0.26 m^3/h / 5x5) or 10 mm/h.

IW can be calculated as 1380 mm/season (7040 m^3/5100 m^2).

Total irrigation time was reported as an average of 2-yr 161 h for sprinkler irrigated grass at Utah Botanical Garden with 432 mm precipitation [13]. The finding obtained present study is inline with [13].

The applied water by sprinkler irrigation system to grassland area was around 1380 mm so it is high. Therefore, area-size with dry tolerant plants should be widening for maximizing water productivity in such semi-arid environment. In study [13], the irrigation water for sprinkler-irrigated turf grass for 2009 and 2010 was calculated as about 726 mm, and 837 mm, respectively. This result is none conformity with our findings, and the reason could be differences in environmental conditions, characteristics of plants and management of irrigation systems in both the research sites.

3.2.2 Drip irrigation system

The irrigation time for drip irrigated area during irrigation season was also 135 h. The drip-irrigated area was about 2250 m^2 and there were 8560 emitters in such area. As mentioned above dripper discharge was found 3 L/h. By using that information, IW was calculated as;

IW = 8560 x 3 L/h x 135 h = 1926000 L = 3466 m^3.

IW = (3466 m^3 / 2250 m^2) x 1000 = 1540 mm/season

The water application duration for different woody plants irrigated by drip irrigation system was mentioned around average 100 h for 2-yr study seasons [13]. The result of current study is lower than [13]. The reasons are possible use of higher drip flow rate, greater than 50 L/h, in Utah research site than our study fields, and differences in environmental conditions for both the research site.

The irrigation water for drip-irrigated woody plants was mentioned as 543 mm, and 628 mm for 2009, and 2010, respectively for Utah conditions [13]. The result obtained current study was greater than [13], and differences can be resulted from irrigation systems, grass types and climates in both the study regions.

IV. SOME RECOMMENDATIONS FOR BETTER WATER SAVINGS

Some parts of the irrigation areas received not enough water possibly due to variations in elevations consequently pressure changes through the pipelines. Therefore, preference of drip laterals with pressure compensation emitters could well solution for high water distribution uniformity across to the field.

In accordance with one study [14], poor water applications in landscape areas can be associated from deficiencies in design and management of the irrigation systems in field level.

In general lateral was found greater than recommended lengths by firms. Thus, laterals should be installed to the lands in accordance with advises by producer company. There was emitter-clogging problem in some emitters. The problem can be solved by use of filters or other technical attempts.

V. CONCLUSION

Proper design of irrigation systems is very important role to play for desired amount of water application for plants. Pressurized irrigation systems are very beneficial for resulting maximal water application efficiency that is vital important particularly poor water ecologies as well as nice growing of plants under proper management. The land-size having drought resistance plants should be widen for reducing water consumption, and to put more areas into the agro-production. Agriculture including landscape activities has used the highest fresh water worldwide so water saving should be started in irrigation at first.

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Genotype-Environment Interaction Studies Over Seasons for Kernel Yield in Maize (*Zea mays L.*)

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Abstract— *Forty five single cross hybrids derived from 10 inbred lines of maize were tested for kernel yield across three seasons viz., rabi, summer and kharif adopting AMMI model to assess the G × E interaction and to identify the stable hybrids for kernel yield. Seasons were found to contribute to the variations in performance of hybrids indicating that unpredictable seasonal conditions are one of the constraints in selecting superior and adaptable hybrids. The hybrids viz., BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × Heypool, DFTY × PDM 1452 and Heypool × PDM 1474 across seasons recoded significantly higher kernel yield over general mean. The first two interaction principal components viz., PC 1 (74.00 %) and PC 2 (16.00 %) of GGE-biplot analysis explained 90.00 % of total variation caused by genotype × environment interaction. Hybrids viz., DFTY × Heypool, BML 15 × PDM 1452 and Heypool × PDM 1474 were the vertex hybrids or winners indicating that they are the best performing or responsive hybrids. Summer season was found to be the most discriminating season in culling the unproductive ones and also to save time and expenditure. Kharif and rabi seasons were the most representative testing seasons for kernel yield. Hybrids viz., BML 2 × DFTY, BML 2 × Heypool, BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × PDM 1452, Heypool × PDM 1474 and PDM 1452 × PDM 1474 were more stable as well as high yielding, whereas DFTY × Heypool, BML 15 × PDM 1452, BML 15 × Heypool and DFTY × PDM 1474 were more variable but high yielding. The hybrids BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × Heypool and Heypool × PDM 1474 were located near to ideal genotype with high mean and stability and could be ranked as desirable hybrids for kernel yield.*

Keywords— Maize, AMMI GGE biplot analysis, Kernel yield, Genotype × environment interaction.

I. INTRODUCTION

Maize is an important cereal crop worldwide and is ranked third after wheat and rice for its nutritional quality and uses Cassamon,; Ali *et al*, 2014. It is mostly used as a food, feed, forage, green fuel, vegetable oil and starch and is the backbone of the poultry feed industry. Kernel yield is a quantitative character, which depends on several yield contributing factors. Genotype × environment interaction reduces the association between the phenotype and genotype which in-turn reduces the selection response (Yan and Kang, 2003). Genotype–environment interactions may cause inconsistencies in genotype ranking across environments. Therefore, testing of identification and interpretation of G × E interaction is essential to make genetic progress (Kang, 2002 and Crossa, 2012). In the process of breeding, newly developed hybrids should be tested in multiple environments to determine the performance and stability before their commercial release. Multi environment trials aids in identification and recommendation of superior stable genotypes in mega environments. Seasons were found to contribute to the variations in performance of hybrids indicating that unpredictable seasonal conditions are one of the constraints in selecting superior and adaptable hybrids. AMMI model combines analysis of variance for the genotype and environment main effects with principal components analysis of the G × E interactions (Gauch and Zobel, 1996). It is useful in statistical analysis of comparative experimental yield clarify the effect of genotype in the environment, patterns and relationship of genotypes and the environment and also for improving the precision of yield estimation (Zobel *et al*, 1988; Crossa *et al*., 1990 and Annicchiarico, 2002). The present study was carried out to identify superior experimental hybrids as well as to select the best environment (Season) for testing hybrids developed in the maize breeding through AMMI biplot method.

II. MATERIAL AND METHODS

Forty five single cross hybrids developed from 10 inbred lines (BML 2, BML 6, BML 7, BML 15, DFTY, Heypool, PDM 1416, PDM 1428, PDM 1452 and PDM 1474) of maize through diallel mating design were evaluated for their performance over three seasons *viz*., *rabi*, *summer* and *kharif* from 2016-17 to 2017-18 at Agricultural Research Station, Perumallapalli, A.P. The experiment was laid out in a randomized block design with three replications with five meters row length. A spacing of 75 × 20 cm in *kharif* and 60 × 20 cm in *summer* and *rabi* between rows and plant to plant, respectively was followed. The two seeds per hill were dibbled and thinning operation was carried out one week after germination to maintain single plant per hill. All the recommended package of practices were adopted in raising a healthy crop. Data were recorded for 15 morpho-physiological and yield contributing characters on five randomly selected plants and whole plot basis in each replication. The mean values for different characters were analysed according to Panse and Sukhatme (1978). The AMMI model (The Additive Main Effects and Multiplicative Interaction) was used to assess the G × E interaction (Hybrids × Seasons) according to Gauch and Zobel (1996). Statistical data analysis was performed using Genstat 12th computer statistical program (Genstat, 2009). AMMI analysis was performed in Excel biplot Macros (Johnson and Bhattacharya, 2020).

III. RESULTS AND DISCUSSION

Pooled mean data analysis of variance over seasons was carried out after testing for homogeneity of error variances using Bartlett,s test. Pooled analysis of the variance for kernel yield was presented in Table 1. Partitioning of total sum of squares to the additive (genetic) and non-additive (ecological) component through analysis of variance indicated the significant differences among hybrids, seasons and hybrids × seasons interactions. The expression of the character not only depends on genetic factors but also on the external environment (Borojevic, 1965). The results of analysis of variance reveal that the proportion of the total variance of kernel yield attributable to seasons (41.66 %) was higher than the hybrids (34.28 %) and hybrids × seasons interaction (12.29 %) (Table 1). Significant hybrids × seasons interaction indicated that rank of genotypes varry at all the three seasons.

TABLE 1
POOLED DATA ANALYSIS OF VARIANCE FOR KERNEL YIELD (g plant^{-1}) OF MAIZE OVER SEASONS

S.No	Source of variation	DF	Mean sum of squares	Per cent contribution (%)
1	Hybrids	44	909.32**	34.28
2	Seasons	2	24310.68**	41.66
3	Hybrids × Seasons	88	163.01**	12.29
4	Pooled Error	264	51.11	1.19
5	Total	404	116713.89	

Note: per cent contribution were worked out based on sum of squares; *Significant at 5% level, **Significant at 1% level

Kernel yield among hybrids ranged from 103.93 (BML 15 × PDM 14298) to 146.70 (BML 7 × DFTY) with a mean of 129.90 g in *rabi*; from 96.27 (BML 7 × BML 15) to 142 57 (Heypool × PDM 1474) with a mean of 126 26 g in *kharif* and from 86.94 (PDM 1428 × PDM 1452) to 129.03 (DFTY × Heypool) with a mean of 105.18 g per plant in *summer*. Pooled mean across seasons varied from 98.77 (BML 15 × PDM 1428) to139.19 (Heypool × PDM 1474) with a general mean of 120.56 g per plant. The hybrids *viz*., BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × Heypool, DFTY × PDM 1452 and Heypool × PDM 1474 across seasons recoded significantly higher kernel yield over general mean (Table 2).

TABLE 2
MEAN PERFORMANCE OF MAIZE HYBRIDS ACROSS SEASONS FOR KERNEL YIELD (g plant^{-1}) IN MAIZE

S.No	Hybrid(s) No.	Parentage	*Rabi*	*Summer*	*Kharif*	Mean over season
1	H1	BML2×BML6	135.50	102.27	138.63	125.47
2	H2	BML2×BML7	142.73	108.23	131.60	127.52
3	H3	BML2×BML15	124.77	95.73	119.73	113.41
4	H4	BML2×DFTY	129.17	107.40	133.17	123.24
5	H5	BML2×Heypool	143.88	116.33	128.23	129.48
6	H6	BML2×PDM1416	127.50	96.93	136.67	120.37
7	H7	BML2×PDM1428	116.13	110.90	117.27	114.77
8	H8	BML2×PDM1452	128.57	97.27	131.60	119.14
9	H9	BML2×PDM1474	131.33	118.00	132.37	127.23
10	H10	BML6×BML7	120.43	94.87	118.47	111.25
11	H11	BML6×BML15	114.87	94.67	118.52	109.35
12	H12	BML6×DFTY	138.90	117.10	120.10	125.37
13	H13	BML6×Heypool	126.03	107.83	130.83	121.57
14	H14	BML6×PDM1416	137.57	105.47	130.50	124.51
15	H15	BML6×PDM1428	122.30	98.57	120.53	113.80
16	H16	BML6×PDM1452	137.53	106.33	124.03	122.63
17	H17	BML6×PDM1474	145.83	122.93	132.13	133.63
18	H18	BML7×BML15	135.10	91.13	96.27	107.50
19	H19	BML7×DFTY	146.70	126.47	138.40	137.19
20	H20	BML7×Heypool	134.43	90.49	135.53	120.15
21	H21	BML7×PDM1416	107.80	90.00	117.48	105.09
22	H22	BML7×PDM1428	120.62	108.40	118.13	115.72
23	H23	BML7×PDM1452	136.07	91.80	120.57	116.14
24	H24	BML7×PDM1474	122.07	113.33	131.67	122.36
25	H25	BML15×DFTY	129.40	92.47	135.93	119.27
26	H26	BML15×Heypool	143.90	100.33	131.27	125.17
27	H27	BML15×PDM1416	110.47	99.03	108.73	106.08
28	H28	BML15×PDM1428	103.93	90.07	102.30	98.77
29	H29	BML15×PDM1452	144.73	108.93	139.80	131.16
30	H30	BML15×PDM1474	143.77	125.73	141.53	137.01
31	H31	DFTY×Heypool	143.20	129.03	138.93	137.06
32	H32	DFTY×PDM1416	111.03	111.93	120.80	114.59
33	H33	DFTY×PDM1428	128.83	114.43	136.37	126.54
34	H34	DFTY×PDM1452	143.40	120.27	135.37	133.01
35	H35	DFTY×PDM1474	138.17	97.53	139.73	125.14
36	H36	Heypool×PDM1416	120.73	96.75	126.90	114.79
37	H37	Heypool×PDM1428	124.13	107.83	121.40	117.79
38	H38	Heypool×PDM1452	138.80	104.97	138.63	127.47
39	H39	Heypool×PDM1474	145.77	129.23	142.57	139.19
40	H40	PDM 1416 × PDM 1428	105.97	97.67	104.00	102.54
41	H41	PDM 1416 × PDM 1452	114.53	93.63	113.43	107.20
42	H42	PDM 1416 × PDM 1474	138.73	99.53	131.10	123.12
43	H43	PDM 1428 × PDM 1452	114.07	86.94	105.87	102.29
44	H44	PDM 1428 × PDM 1474	133.67	102.67	129.33	121.89
45	H45	PDM 1452 × PDM 1474	142.40	111.73	130.70	128.28
		Grand Mean	**129.90**	**105.18**	**126.60**	**120.56**

The hybrids × seasons interaction was further partitioned in to two principal components (PCA 1 and PCA 2) through AMMI analysis. The first two interaction principal components *viz.*, PC 1 (74.00 %) and PC 2 (16.00 %) of GGE-biplot analysis explained 90.00 % of total variation caused by genotype + genotype × environment interaction and hence is considered satisfactory. The use of GGE biplot analysis helps in determining stable performing hybrids for kernel yield. Hybrids in different ecological conditions possessing the higher value of the first component close to zero were noted as stable (Sabaghniaa *et al*. 2006) .The high value of PCA 2 indicates that the best expression of the character in a specific environmental conditions (Bozovic *et al*., 2018). In this regard, AMMI is more suitable in the initial statistical analysis of yield trials which provides estimate of G × E interactions and summarizes the various pattern and relationships among genotypes and environments (Crossa *et al*., 1990). PCA scores of hybrids showed both positive and negative values in the present study.

The GGE biplot analysis which provides graphical display is considered as an innovative methodology or applied plant breeding (Yan *et al*. 2000). The which-won-where pattern, relationships among test seasons and hybrids were visualized using their respective GGE biplots. GGE analysis was performed to study the relationship between and among seasons. The principal components of GGE biplots for kernel yield of hybrids evaluated in three seasons *viz*., first principal component (PCA 1) and the second principal component (PCA 2) sores were plotted against X axis Y axis, respectively. The polygon view of tested hybrids during three seasons was presented in Fig 1. All three seasons fell into one sector, whereas hybrids were grouped in all the sectors indicating that a single cultivar had the highest yield in all the environments. Hybrids *viz*., 31 (DFTY × Heypool), 29 (BML 15 × PDM 1452) and 39 (Heypool × PDM 1474) were the vertex hybrids or winners indicating that they are the best performing or responsive hybrids (Fig. 1).

Lengths of season vectors are proportional to standard deviation of genotype yield in a corresponding treatment. Seasons having long vectors classify hybrids more when compared to seasons with short vector. *Summer* season was the most discriminative season for kernel yield. The test seasons presenting shorter angles were the most representative ones. Accordingly, in the present study *rabi* and *kharif* seasons were found most representative seasons for kernel yield (Fig. 2).

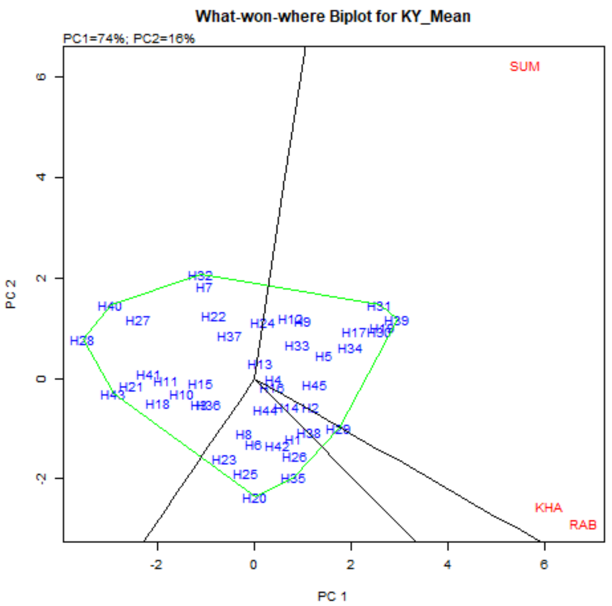

FIGURE 1: Which won where pattern of GGE biplot for kernel yield in maize

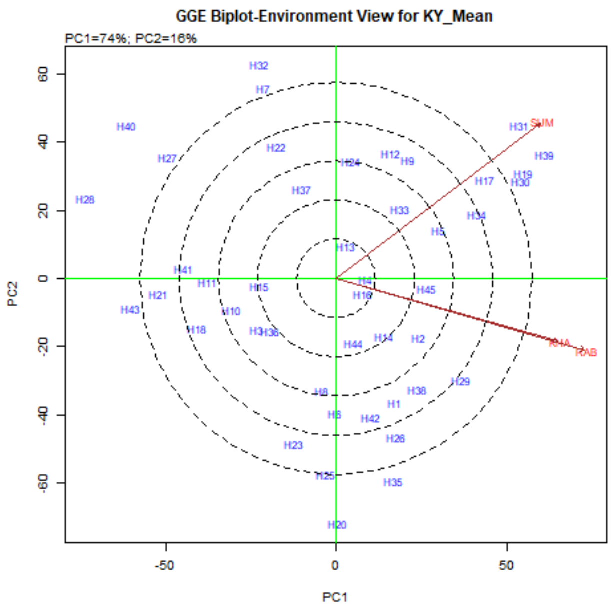

FIGURE 2: Discriminativeness *vs* representativeness of seasons for kernel yield in maize

Yield performance and stability of hybrids was evaluated by an average environment coordination (AEC) method. Hybrids *viz*., 4 (BML 2 × DFTY), 5 (BML 2 × Heypool), 17 (BML 6 × PDM 1474), 9 (BML 7 × DFTY), 30 (BML 15 × PDM 1474), 34 (DFTY × PDM 1452) and 45 (PDM 1452 × PDM 1474) were more stable as well as high yielding, whereas 31 (DFTY × Heypool), 29 (BML 15 × PDM 1452), 26 (BML 15 × Heypool) and 35 (DFTY × PDM 1474) were more variable but high yielding (Fig. 3). Kaplan *et al*. (2017), Mebratu *et al*., (2019), Garoma *et al*., (2020) and Ramesh Kumar *et al*., (2020) have also reported that GGE Biplot method can be used to reliably in the evaluation of different maize genotypes grown in different environments.

Genotypes with high average yield with relatively stable in performance across environments is referred as ideal genotypes and such genotypes are present at the center of concentric circle in GGE-biplot. Hybrids ranking on the basis of mean yield and stability in comparison to ideal genotype were depicted in Fig 4. Hybrids *viz*., 17 (BML 6 × PDM 1474), 19 (BML 7 × DFTY), 30 (BML 15 × PDM 1474), 31 (DFTY × Heypool), 34 (DFTY × PDM 1452) and 39 (Heypool × PDM 1474) were located near to ideal genotype and could be ranked as desirable hybrids stable with high mean yield and stable in performance for kernel yield.

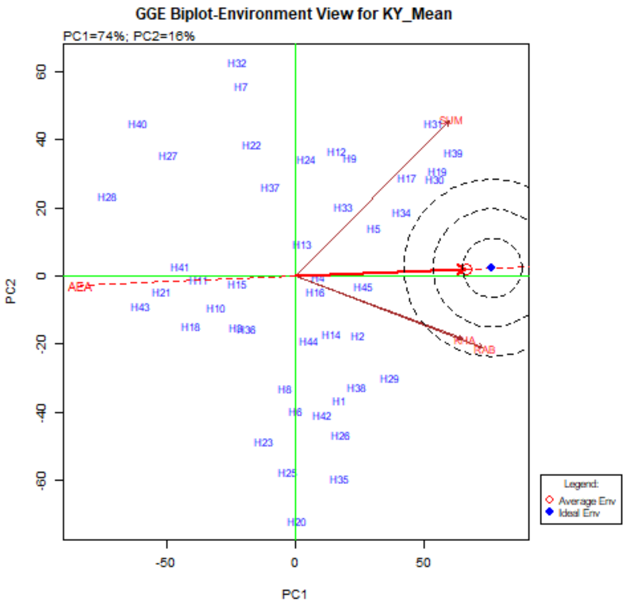

FIGURE 3: Mean vs Stability for kernel yield in maize

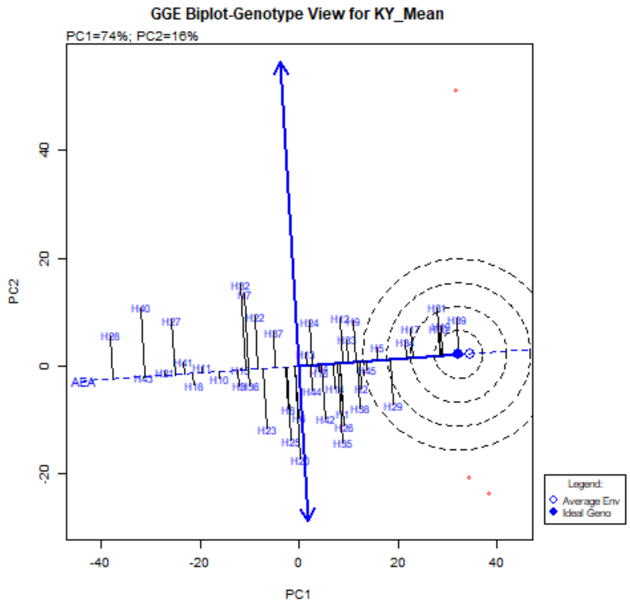

FIGURE 4: Ranking pattern of hybrids in relation to ideal genotype for kernel yield in maize

IV. CONCLUSIONS

Seasons were found to contribute to the variations in performance of hybrids indicating that unpredictable seasonal conditions are one of the constraints in selecting superior and adaptable hybrids. The hybrids *viz*., BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × Heypool, DFTY × PDM 1452 and Heypool × PDM 1474 across seasons recoded significantly higher kernel yield over general mean. Hybrids *viz*., DFTY × Heypool, BML 15 × PDM 1452) and Heypool × PDM 1474 were the vertex hybrids or winners indicating that they are the best performing or responsive hybrids. *Summer* season was found to be the most discriminating season in culling the unproductive ones and to save time and expenditure. *Kharif* and *rabi* seasons were the most representative testing seasons for kernel yield. Hybrids *viz*., BML 2 × DFTY, BML 2 × Heypool, BML6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × PDM 1452, Heypool × PDM1474 and PDM 1452 × PDM 1474 were more stable as well as high yielding. Hybrids close to the ideal genotype were ranked as the ones with high mean and phenotypic stability. The hybrids *viz*., BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × Heypool and Heypool × PDM 1474 were located near to ideal genotype with high mean and stability and could be ranked as desirable hybrids for kernel yield.

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