Impact of Moisture Conservation Practices and Zinc Fertilization on Growth Parameter, Yield Attributes and Yield of Pearlmillet \([Pennisetum glaucum (L.)]\) under Limited Moisture Conditions

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A B S T R A C T

A field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during kharif, 2017 to find out the effect of moisture conservation practices and zinc fertilization on growth, yield and quality of pearlmillet. The experiment consisted of 20 treatment combinations of five moisture conservation practices i.e. control, dust mulch, pusa hydrogel, stover mulch and pusa hydrogel + stover mulch and four zinc fertilization levels \(i.e.\) control, 2 kg Zn/ha, 4 kg Zn/ha and 6 kg Zn/ha. Stover mulch recorded significantly higher plant height, dry matter accumulation, grain weight per ear heads, total number of tillers and effective tillers as compared to control, dust mulch and pusa hydrogel but remained at par with pusa hydrogel + stover mulch. Under zinc fertilization treatments application of 6 kg Zn/ha and 4 kg Zn/ha being at par with each other and proved significantly better over control, 2 kg Zn/ha in term of growth parameter, yield attributes and yield in pearlmillet. Final results revealed that application of stover mulch and 4 kg Zn/ha to pearlmillet were proved to be better.

Introduction

Pearl millet \([Pennisetum glaucum (L.)] R. Br.\) commonly known as bajra, is an important drought hardy millet crop basically cultivated in the arid and semi-arid areas on light textured sandy soils. It is one of the major coarse grain crops and is considered to be a poor man’s food. Pearl millet grains are used for human consumption, its fodder as cattle feed and also used as feed for poultry. It is also grown and used for hay, pasture, silage, seed crops, food, building material and fuel. In India it is presently cultivated in area of 7.47 million hectare and producing 9.80 million tonnes with productivity of 1312 kg...
per hectare. In India major pearl millet producing state are Rajasthan (45%), Uttar Pradesh (18%) and Haryana (10%) and Gujarat (9%). In Rajasthan, Pearl millet is grown over an area of about 4.15 million hectare with the production of 4.16 million tones with average productivity 1001 kg per hectare (Anonymous, 2017). In Rajasthan, Alwar, Sikar, Nagaur, Jaipur, Jodhpur and Jhunjhunu are major pearl millet producing districts with respect to area and production but productivity remains highest (2095 kg ha$^{-1}$) in Dholpur district.

Mulching is also one of the most important cultural technologies for conserving moisture in rainfed farming system. Mulch is reported to conserve soil moisture, protect soil from erosion, reduce soil temperature, minimize evaporation loss and enhance root growth. Dust mulching decrease evaporation on the assumption that dry soil acts as a blanket and also reduce the point of contact between the soil particles due to loosening attraction between them. Application of crop residue on soil surface as a mulch reduces the loss of water through evaporation and moderate the soil profile temperature (Ram et al., 2012). There is 40 to 70 percent saving of water by the use of pusa hydrogel. Hydrogel reduces the leaching of herbicide, fertilizer and irrigation requirements for crops. It also promotes early dense flowering and tillering and delay the permanent wilting point (Mehr and Kourosh, 2008). At present, widespread and acute deficiency of zinc is another serious problem in arid and semi-arid region (Sahrawat et al., 2007).

Zn deficiency is occurring in both crops and human. Zinc deficiency reduces not only the grain yield, but also the nutritional quality of grain (Cakmak, 2008) and ultimately nutritional quality in human diet. Zinc plays a vital role in synthesis of chlorophyll, protein and nucleic acid and helps in the utilization of nitrogen and phosphorous by plants as it acts an activator of dehydrogenase and proteinase enzymes, directly and indirectly in synthesis of carbohydrates and protein. Zinc is constituent of tryptophan which is precursor of auxin hormone. Chaube et al., (2007) and Badiyala and Chopra (2011) were reported that use of Zn increase the productivity as well as improve the fertility status of soil. Thus, keeping these facts in view, a research problem was undertaken to find out the effect of zinc fertilization under different moisture conservation practices on yield and economics of pearlmillet under rainfed conditions.

Materials and Methods

The present investigation entitled “Effect of moisture conservation practices and zinc fertilization on growth, yield and quality of pearlmillet (Pennisetum gалаucum L.) Under rainfed condition” was carried out during kharif 2017 at Agronomy Farm of S.K.N. College of Agriculture, Jobner (26° 05' N latitude and 75° 28' E longitude and at an altitude of 427 metres above mean sea level). The region falls in Agro-climatic zone III-a (Semi-Arid Eastern Plain) of Rajasthan. The climate of this region is a typically semi-arid, characterized by extremes of temperature during both summers and winters. The average annual rainfall of this tract varies from 300 mm to 400 mm and is mostly received during the month of July to September. During summer, temperature may go as high as 48°C while in winter, it may fall...
as low as -1.5 °C. the relative humidity fluctuates between 43 to 87 per cent. The experimental soil was loamy sand in texture with high infiltration rate (22.4 cm/hr) and saturated hydraulic conductivity 10.20 cm/h. The soil was low in organic carbon (0.24%), low available nitrogen (125.7 kg N/ha) and Zn (0.4 mg/kg of soil), medium in available phosphorus (16.12 kg P₂O₅/ha) and in available potassium (151.24 kg K₂O/ha). The soil was non saline with a pH value of 8.2. The experiment was non saline with pH value of 8.2. The experiment was laid out in randomized block design (RBD) comprised of five treatments of moisture conservation practices (control, dust mulch, pusa hydrogel, stover mulch and pusa hydrogel + stover mulch) and four treatments of zinc fertilization (control, 2.0 kg Zn/ha and 4.0 kg Zn/ha and 6.0 kg Zn/ha) in pearl millet with three replications.

The pearl millet variety ‘RHB-173’ was taken for experiment and planted at 45 cm x 10 cm spacing. Pusa hydrogel was applied irrespective plots as band and Zinc fertilization treatments were applied as per treatment through zinc sulphate (ZnSO₄.7H₂O) containing 21% zinc and 10% S at the time of sowing as basal dose. The crop was grown with recommended package of practices. The weight of the thoroughly sun dried harvested produce from net area of each plot was recorded separately before threshing and expressed as biological yield in kg/ha. After proper drying harvested produce were threshed separately.

Grain yield from each net plot was recorded and computed as grain yield kg/ha. The stover yield for each plot was worked out by subtracting grain yield from total biomass of each net plot and stover yield was expressed in kg/ha. Economics of different treatment was worked out by taking into account the cost of inputs and income obtained from output based on the prevailing market price.

Results and Discussion

Effect of moisture conservation practices on pearl millet

Effect on growth attributes

The moisture conservation practices did not significantly influenced on plant stand at 20 DAS and harvest. Growth parameters viz., plant height, dry matter accumulation, and total number of tillers was significantly influenced by moisture management practices. Significantly taller plants (149.60 and 173.74 cm at 60 DAS and at harvest, respectively) were observed under the treatment stover mulch which was at par with pusa hydrogel + stover mulch. The data presented in Table-1 revealed that dry matter accumulation of pearl millet per metre row length recorded at 30, 60 DAS and at harvest was found significantly higher in stover mulch which was at par with pusa hydrogel + stover mulch. Among the moisture conservation practices on average significantly higher number of tillers (4.77) per plant recorded at harvest under treatment stover mulch. Rapid decomposition of organic residue helped in greater availability of nutrients, which led to increase in growth and yield attributes and finally the grain yield. Similar findings were also reported by Kumar and Gautam (2004) and Parihar et al., (2012).

Effect on yield and yields attributes

The different soil moisture conservation practices significantly influenced yield attributing and yields of pearl millet. The result revealed that treatment stover mulch recorded significantly the highest values of effective tillers per plant, number of grains per ear, length of ear, test weight, than control, dust mulch and pusa hydrogel but remained at par with pusa hydrogel + stover mulch.
Table 1 Effect of moisture conservation practices and zinc fertilization on growth parameter of pearlmillet

| Treatments                                | Plant stand/ m row | Plant height (cm) | Dry matter accumulation (g/mrl) |
|-------------------------------------------|--------------------|------------------|---------------------------------|
|                                           | 20 DAS             | 30 DAS 60 DAS    | 30 DAS 60 DAS At harvest        |
| Moisture conservation practices           |                    |                  |                                 |
| Control                                   | 7.19 7.05          | 29.65 114.44     | 132.47 15.06 99.48 135.52       |
| Dust mulch                                | 7.28 7.12          | 29.95 126.50     | 146.23 17.02 109.29 147.51      |
| Pusa hydrogel                             | 7.31 7.17          | 30.20 138.50     | 160.69 19.49 119.82 160.09      |
| Stover mulch                              | 7.33 7.19          | 31.40 149.60     | 173.74 21.50 129.97 173.05      |
| Pusa hydrogel + stover mulch              | 7.38 7.25          | 31.99 154.30     | 179.39 22.41 136.81 181.29      |
| SEM+                                      | 0.18 0.18          | 0.99 3.61        | 4.22 0.52 3.19 4.24             |
| CD (P=0.05)                               | NS NS NS           | 10.32 12.08      | 1.49 9.14 12.13                 |
| Zinc level (kg Zn/ha)                     |                    |                  |                                 |
| 0                                         | 7.21 7.01          | 29.49 119.75     | 136.54 15.54 102.26 139.06      |
| 2                                         | 7.26 7.17          | 30.47 132.09     | 149.97 18.33 115.17 153.44      |
| 4                                         | 7.34 7.21          | 31.06 144.85     | 170.64 20.78 126.39 169.28      |
| 6                                         | 7.37 7.23          | 31.55 149.98     | 176.87 21.73 132.48 176.19      |
| SEM+                                      | 0.16 0.16          | 0.89 3.23        | 3.77 0.47 2.85 3.79             |
| CD (P=0.05)                               | NS NS NS           | 9.23 10.80       | 1.34 8.17 10.85                 |
Table 2: Effect of moisture conservation practices and zinc fertilization on yield attributes and yield of pearl millet

| Treatments                  | Total Tillers/plant | Effective tillers/plant | Number of grain/ear | Ear length (cm) | Test weight (g) | Grain yield (kg/ha) |
|-----------------------------|---------------------|-------------------------|---------------------|-----------------|-----------------|---------------------|
| Moisture conservation practices |                     |                         |                     |                 |                 |                     |
| Control                     | 3.56                | 2.08                    | 724.53              | 18.71           | 5.84            | 1905               |
| Dust mulch                  | 3.97                | 2.35                    | 795.30              | 20.67           | 6.40            | 2112               |
| Pusa hydrogel               | 4.37                | 2.61                    | 875.40              | 22.87           | 6.95            | 2306               |
| Stover mulch                | 4.77                | 2.89                    | 978.45              | 24.79           | 7.49            | 2511               |
| Pusa hydrogel + stover mulch| 4.98                | 3.06                    | 1040.20             | 25.81           | 7.91            | 2613               |
| SEM+                        | 0.12                | 0.07                    | 24.00               | 0.56            | 0.18            | 60                 |
| CD (P=0.05)                 | 0.34                | 0.20                    | 68.71               | 1.60            | 0.53            | 173                |
| Zinc level (kg Zn/ha)       |                     |                         |                     |                 |                 |                     |
| 0                           | 3.54                | 2.20                    | 764.63              | 19.66           | 6.11            | 1954               |
| 2                           | 4.19                | 2.45                    | 832.49              | 21.89           | 6.66            | 2246               |
| 4                           | 4.69                | 2.80                    | 942.52              | 23.97           | 7.29            | 2470               |
| 6                           | 4.90                | 2.94                    | 991.46              | 24.76           | 7.61            | 2486               |
| SEM+                        | 0.10                | 0.06                    | 21.47               | 0.50            | 0.16            | 54                 |
| CD (P=0.05)                 | 0.30                | 0.18                    | 61.46               | 1.43            | 0.47            | 155                |
Yield attributes and yield could be attributed to improvement in growth attributes through availability of more moisture and nutrients, which in turn favourably influenced number of physiological processes like transpiration, photosynthesis and build-up of food material. The increase in grain yield with increase in yield attributes may also be supported by significant and positive correlation between grain yield and yield attributes. These results are in conformity with findings of Sujatha et al., (2013) Menaka et al., (2008), Jalota et al., (2007), and Tetarwal and Rana (2006).

**Effect of zinc fertilization in pearl millet**

**Effect on growth attributes**

Zinc fertilization with 4 and 6 kg Zn/ha being at par with each other, proved significantly better over control and 2 kg Zn/ha in terms of growth parameters (plant height, dry matter accumulation and total number of tillers), at most of the growth stages of pearl millet. The favourable influence of applied zinc on different growth parameters of pearl millet ascribed to its involvement in various metabolic activities, controlling auxin levels and nucleic acids. The improvement in growth parameters with zinc fertilization were also reported by Jakhar et al., (2006), Badiyala and Chopra (2011), Gupta and Sahu (2012) and Singh and Bhati (2013).

**Effect on yield attributes**

The considerable improvement in yield attributes viz., number of effective tillers, number of grains per ear, weight of ear, length of ear and test weight were observed due to zinc fertilization. Increasing levels of zinc fertilization up to 4.0 kg Zn/ha significantly increased the number of effective tillers, number of grain, and 1,000-grain weight of pearl millet as compared to control and 2 kg Zn/ha but it was at par with 6 kg Zn/ha. Zinc plays an important role in nitrogen metabolism and formation of chlorophyll and carbohydrate, which leads to maintain photosynthetic activity for longer period and finally results in increasing the yield attributes of the crop. Similar findings were also reported by Mehta et al., (2008), Ram Pratap et al., (2008) and Jyothi et al., (2013). Zinc plays a pivotal role in regulating the auxin concentration in plant and nitrogen metabolism and might have improved these growth attributes. In dry land areas Zn application increases root absorption of minerals; these results are in close conformity with those of Dashadi et al., (2013) and Kumawat et al., (2015).

Based on the results of this experiment, it may be concluded that in moisture conservation practices stover mulch was found significantly most suitable treatment for obtaining higher growth and yield attributes but it was at par with pusa hydrogel + stover mulch and in zinc fertilization 4 kg Zn/ha was found significantly superior than control and 2 kg Zn/ha but it was at par with 6 kg Zn/ha. However, these results are only indicative and require further experimentation to arrive at more consistent and final conclusion.

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