www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(6): 599-601

www.thepharmajournal.com
Received: 22-04-2021
Accepted: 24-05-2021

G Jaya Prathiksha
Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India

Joy Dawson
Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India

Corresponding Author:
G Jaya Prathiksha
Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India

Effect of nitrogen levels and intercropping on nitrogen uptake parameters and chemical analysis of soil in pearl millet intercropped with legumes

G Jaya Prathiksha and Joy Dawson

Abstract
This experiment was conducted to guage the effect of intercropping and nitrogen levels on nutrient uptake parameters and chemical analysis of pearl millet intercropped with legumes (cowpea and green gram). It was laid down in a randomized block design with thirteen treatments replicated thrice. The experiment was conducted during *kharif* 2017 and 2018 in Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The Agronomic Efficiency, Physiological Efficiency and Agro-Physiological Efficiency were maximum in the sole cropping of pearl millet with nitrogen applied at 40 kg/ha. The chemical analysis of the soil revealed that the Organic Carbon, Electrical Conductivity and pH of the soil showed no significant difference between the treatments after the harvest of the crop.

Keywords: agronomic efficiency, physiological efficiency, agro-physiological efficiency, organic carbon, electrical conductivity, pH

Introduction
Pearl millet (*Pennisetum typhoides* L.) is one of the most important cereal crops grown in the tropical region. It ranks fourth after rice, wheat and sorghum and is grown in almost all the states of the country. Limited availability of land resources and the decline in the soil fertility has increased the importance of the ability of agriculture to sustain the increasing demand of the population both globally and locally. To counter the demand, we have to look for ways which enhance the use of currently available resources than in the past. Intercropping is one promising practice which is effective to augment the total productivity per unit area of the land per unit time by growing more than one crop in the same field with an objective of better utilization of environmental resources. The basic concept of intercropping involves growing together two or more crops with the assumption that two crops can exploit the environment better than one and ultimately produce higher yield (Reddy and Willy, 1981) [6]. Cereal-legume intercropping has attracted the attention of agronomists, possibly as a result of the established and theoretical advantages of intercropping systems (Ofori and Stern, 1978) [5]. Intercropping with legumes is a practice in which N fixed by latter enhances the qualitative and quantitative traits of the former to finally reach food security and sustainability (Swaminathan, 1998) [7]. Legumes such as cowpea, cluster bean and green gram are known to fix the atmospheric nitrogen with the help of rhizobium bacteria and it supplies the cereal crop with the required nitrogen. Our present study is conducted to evaluate the effect of intercropping legumes i.e., cowpea and green gram with pearl millet and different nitrogen levels on the growth and yield of the legumes. Our present study was conducted to evaluate the effect of nitrogen levels and intercropping of pearl millet with legumes on the nitrogen uptake parameters and the soil chemical status after the harvest of the crop.

Materials and Methods
The field experiment was conducted at the Crop Research Farm of Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences during kharif 2017 and 2018. The experimental soil was sandy loam with pH (7.1 and 7.3), EC (0.80 and 0.74 dS/m), OC (0.48 and 0.45), available N (108.0 and 103.2 kg/ha), P (27.0 and 25.2 kg/ha) and K (302.4 and 296.8 kg/ha) during both the experimental years. The cultivars used for pearl millet was KSBH-66, cowpea was Improved AK-57 and green gram was PDM-139 (Samrat). The experiment was laid down in a randomized block design with thirteen treatments.

The two factors included fertility levels [0 (Pearl millet), 20 (Cowpea/green gram), 40 (Pearl millet) and 80 (Pearl millet)] and intercrops [Pearl millet (sole crop), pearl millet + cowpea (1:1 ratio), pearl millet + green gram (1:1 ratio)]. The thirteen treatments were sole cropping of pearl millet, cowpea, green gram and intercrops of cowpea and green gram with pearl millet at 0 kg/ha of nitrogen applied, sole crop of cowpea and green gram at 20 kg/ha of N, pure crop of pearl millet, intercrops of cowpea and green gram each at 40 and 80 kg/ha. The rainfall received during the first experimental year was 444.2 mm spread over 27 days. During the second experimental year, the rainfall was 603.2 mm in 42 days during the crop duration. Pearl millet was planted with spacing 45 x 10 cm, cowpea and green gram at 30 x 10 cm in the plots where these were planted as sole crop. Basal dose with about 50% of recommended nitrogen and full dose of phosphorus and potassium were applied. In the plots with intercropping, in between two rows of pearl millet, a row of cowpea/green gram was sown in 1:1 ratio. Nitrogen was applied as basal dose and split doses in the treatments with fertility level as 40 and 80 kg/ha at 25 DAS and 55 DAS.

(i) Agronomic efficiency (AE)

It is the additional grain yield produced due to application of nutrients over unfertilized control per unit of nutrient applied and is expressed in kg/kg (Dobermann, 2007) [2].

$$AE = \frac{GYn - GYo}{Na}$$

Where
GYn = Grain yield with nutrients
GYo = Grain yield without nutrients
Na = Nutrient applied

(ii) Physiological efficiency (PE)

It is the additional biological yield produced due to application of nutrients over unfertilized control and is expressed in kg/kg (Dobermann, 2007) [2].

$$PE = \frac{BYn - BYo}{NUn - NUo}$$

Where,
BYn = Biological yield with nutrients
BYo = Biological yield without nutrients
NUn = Nutrient uptake with nutrients
NUo = Nutrient uptake without nutrients

(iii) Agro-physiological efficiency (APE)

It is the additional grain yield produced due to application of nutrients over unfertilized control and is expressed in kg/kg (Baligar *et al*., 2001) [1].

$$APE = \frac{GYn - GYo}{NUn - NUo}$$

Where,
GYn = Grain yield with nutrients
GYo = Grain yield without nutrients
NUn = Nutrient uptake with nutrients
NUo = Nutrient uptake without nutrients

Chemical analysis of the soil sample was conducted before the sowing of the crop and after the harvest. The soil organic carbon was estimated by chromic acid wet digestion method (Jackson, 1973) [4]. The soil electrical conductivity and soil reaction was determined by the digital conductivity bridge method (Jackson, 1973) [4] and digital pH meter (Jackson, 1973) [4], respectively.

Analysis of variance for randomized block design and significance of variance was tested by F-test (Gomez and Gomez, 1984) [3]. Critical difference for examining treatmental means for their significance was calculated at 5% significance.

Results and Discussion

The nitrogen uptake parameters i.e., agronomic efficiency, physiological efficiency and agro-physiological efficiency was calculated during both the experimental years. It is concluded from our study that the agronomic efficiency (Table 1) during both the experimental years and the mean data was maximum in the pure crop of pearl millet with nitrogen applied at 40 kg/ha (T8). From the mean data, it is observed that the agronomic efficiency was higher in the pure stand treatments (T8 and T11) at both the nitrogen levels i.e., 40 and 80 kg/ha. Among the intercrop treatments, agronomic efficiency was higher for green gram intercropped plots (T10 and T13) at both the levels of nitrogen applied. Pure crop of pearl millet at 40 kg/ha (T8) of nitrogen applied registered an increase of 33% (9.28 kg/kg) in the agronomic efficiency compared to the plot of pure crop with nitrogen applied at 80 kg/ha. However, the intercropped plots of green gram and cowpea have recorded higher agronomic efficiency in the plots where nitrogen was applied at 80 kg/ha compared to 40 kg/ha. Intercropped plot of green gram has registered a minimum loss in the agronomic efficiency (0.46 kg/kg) at 40 kg/ha (T10) compared to the green gram intercropped plot with nitrogen applied at 80 kg/ha (T13). Similarly, the cowpea intercropped plot recorded an increase of 4.03 kg kg-1 in the agronomic efficiency with the application of nitrogen at 80 kg/ha (T12) over 40 kg/ha (T9). The agronomic efficiency of the pure stand at the respective level of nitrogen applied was higher than that of the intercrops at the same level. Intercropping with green gram (T10) and cowpea (T9) recorded a loss of 12.74 kg/kg and 17.25 kg/kg in the agronomic efficiency compared to the pure crop with nitrogen applied at 40 kg/ha. However, this loss was minimum in the plots where nitrogen was applied at 80 kg/ha. Pure stand (T11) recorded 3.0 kg/kg and 3.94 kg/kg increase in the agronomic efficiency in the intercropped plots of green gram (T13) and cowpea (T12), respectively in the plots where nitrogen was applied at 80 kg/ha.

From our data, it is revealed that during the experimental year of 2017 and 2018 along with the mean data, a similar trend was observed in the physiological efficiency and agro-physiological efficiency (Table 1). Application of nitrogen at 40 kg/ha in the pure stand of pearl millet (T8) recorded maximum physiological and agro-physiological efficiency. This was followed by the sole cropping of pearl millet with nitrogen applied at 80 kg/ha (T11). It is observed that the sole cropping of pearl millet at both the levels of nitrogen applied (T8 and T11) recorded higher physiological and agro-physiological efficiency compared to the intercrop treatments. Among the intercrops, green gram (T10 and T13) observed higher physiological and agro-physiological efficiency compared to cowpea (T9 and T12).

The statistical analysis of the soil data (Table 2) from both the

experimental years revealed that there was no significant difference between the treatments. The soil OC, pH and EC. There was no significant difference observed in these soil parameters. However, it can be observed that maximum soil OC, EC and pH during both the experimental years was observed in the pure crop of cowpea with no nitrogen applied (T2). And the lowest was observed in the pure crop of pearl millet with nitrogen applied at 80 kg/ha (T11). All the treatments for these parameters were observed to be statistically at par with each other. The statistical analysis of the pooled data showed significant difference between the treatments under different soil parameters. All the treatments were statistically at par with the pure crop of cowpea with no nitrogen applied (T2) for OC except intercrop of green gram at 40 kg/ha (T10) and pure crop with nitrogen at 80 kg/ha (T11) which were significantly inferior to T2. The pH of the soil showed no significant difference between the treatments. The soil EC was highest in the cowpea pure crop with no nitrogen (T2) and was significantly superior over green gram intercrop (T10 and T13) and pure crop (T8 and T11) with nitrogen applied at 40 and 80 kg/ha, respectively.

Table 1: Effect of nitrogen levels on agronomic, physiological and agro-physiological efficiencies of pearl millet

S. No.	Treatments	Agronomic efficiency (kg/kg)			Physiological efficiency (kg/kg)			Agro-physiological efficiency (kg/kg)		
		2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
1	Pearl millet sole crop (control)	-	-	-	-	-	-	-	-	-
2	Cowpea sole crop (control)	-	-	-	-	-	-	-	-	-
3	Green gram sole crop (control)	-	-	-	-	-	-	-	-	-
4	Pearl millet + Cowpea (1:1 ratio) with Nitrogen at 0 kg/ha	-	-	-	-	-	-	-	-	-
5	Pearl millet + Green gram (1:1 ratio) with Nitrogen at 0 kg/ha	-	-	-	-	-	-	-	-	-
6	Cowpea with Nitrogen at 20 kg/ha	-	-	-	-	-	-	-	-	-
7	Green gram with Nitrogen at 20 kg/ha	-	-	-	-	-	-	-	-	-
8	Pearl millet with Nitrogen at 40 kg/ha	30.93	25.39	28.16	260.96	272.16	266.56	86.33	80.57	83.45
9	Pearl millet + Cowpea (1:1 ratio) with Nitrogen at 40 kg/ha	15.03	6.80	10.91	128.32	59.15	93.73	32.81	18.37	25.59
10	Pearl millet + Green gram (1:1 ratio) with Nitrogen at 40 kg/ha	17.55	13.29	15.42	135.76	119.43	127.59	43.28	38.47	40.87
11	Pearl millet with Nitrogen at 80 kg/ha	15.87	21.9	18.88	180.83	217.09	198.96	55.97	65.37	60.67
12	Pearl millet + Cowpea (1:1 ratio) with Nitrogen at 80 kg/ha	13.84	16.03	14.94	147.71	162.98	155.34	45.33	48.07	46.70
13	Pearl millet + Green gram (1:1 ratio) with Nitrogen at 80 kg/ha	14.20	17.55	15.88	166.65	192.30	179.48	47.29	57.84	52.57

Table 2: Effect of nitrogen levels on organic carbon, pH and electrical conductivity of post-harvest soil sample

S. No.	Treatments	Organic carbon (%)			pH			Electrical conductivity (dS/m)		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
1	Pearl millet sole crop (control)	0.35	0.32	0.33	7.4	7.4	7.4	0.66	0.65	0.66
2	Cowpea sole crop (control)	0.35	0.34	0.35	7.5	7.4	7.4	0.70	0.67	0.69
3	Green gram sole crop (control)	0.35	0.34	0.35	7.4	7.4	7.4	0.67	0.67	0.67
4	Pearl millet + Cowpea (1:1 ratio) with Nitrogen at 0 kg/ha	0.35	0.32	0.34	7.4	7.4	7.4	0.66	0.67	0.66
5	Pearl millet + Green gram (1:1 ratio) with Nitrogen at 0 kg/ha	0.34	0.32	0.33	7.5	7.4	7.4	0.66	0.66	0.66
6	Cowpea with Nitrogen at 20 kg/ha	0.34	0.34	0.34	7.4	7.4	7.4	0.68	0.67	0.68
7	Green gram with Nitrogen at 20 kg/ha	0.35	0.33	0.34	7.4	7.4	7.4	0.67	0.67	0.67
8	Pearl millet with Nitrogen at 40 kg/ha	0.32	0.31	0.32	7.3	7.3	7.4	0.63	0.64	0.63
9	Pearl millet + Cowpea (1:1 ratio) with Nitrogen at 40 kg/ha	0.34	0.32	0.33	7.4	7.4	7.4	0.65	0.65	0.65
10	Pearl millet + Green gram (1:1 ratio) with Nitrogen at 40 kg/ha	0.32	0.31	0.31	7.4	7.4	7.4	0.64	0.65	0.64
11	Pearl millet with Nitrogen at 80 kg/ha	0.32	0.30	0.31	7.3	7.3	7.3	0.63	0.64	0.63
12	Pearl millet + Cowpea (1:1 ratio) with Nitrogen at 80 kg/ha	0.32	0.31	0.32	7.3	7.3	7.4	0.64	0.65	0.65
13	Pearl millet + Green gram (1:1 ratio) with Nitrogen at 80 kg/ha	0.32	0.31	0.32	7.3	7.3	7.3	0.63	0.64	0.64
SE.m+		0.01	0.01	0.01	0.1	0.1	0.04	0.03	0.01	0.01
CD (P = 0.05)		0.03	0.04	0.03	0.2	0.2	0.13	0.07	0.04	0.04
Initial status of the soil sample		0.48	0.45	0.46	7.1	7.3	7.2	0.80	0.74	0.77

References

1. Baligar VC, Fageria NK, He ZL. Nutrient use efficiency in plants. Communications in Soil Science and Plant Analysis 2001;32(7-8):921-950.
2. Dobermann A. Nutrient use efficiency – measurement and management. In "IFA International Workshop on Fertilizer Best Management Practices", Brussels, Belgium 2007, 1-28.
3. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research (1st Edition), John Wiley and Sons, Wiley and Sons, Wiley Inter Science Publication, New York, USA 1984, 680.
4. Jackson ML. Soil Chemical Analysis Prentice-Hall of India Private Ltd, New Delhi 1973.
5. Ofori F, Stern WR. Cereal + legume intercropping system. Advances in Agronomy 1987;41:41-90.
6. Reddy MS, Willy RW. Growth and resource use studies in an intercrop of pearl millet/groundnut. National Symposium, Indian Society of Agronomy, CSSRI, Karnal, 3-5 April, 1980, New Delhi 1981.
7. Swaminathan MS. Crop production and sustainable food security. In: Crop Productivity and Sustainability - Shaping the Future, Chopra VL, Singh RB and Verma A. (eds). Proceedings of the Second International Crop Science Congress, New Delhi, India 1998, 3-18.