Nutrient uptake of maize as influenced by intercropping with different genotype of groundnutunder temperate Kashmir valley

A field experiment on'Nutrient uptake of maize as influenced by intercropping with different genotype of groundnut under temperate Kashmir valley" was conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura, Sopore during 2021 and 2022. The experimental soil exhibited silty clay loam characteristics with adequate drainage and normal levels of both reaction and salinity. The experimental treatments comprised of sole crops and various row proportions of maize intercropped with groundnut. The experimental design was randomized complete block design, consist nineteen treatments that were replicated three times. Treatment comprised of T1(Sole maize, 60cm), T2 (sole paired maize, 75-45-75 cm), T3 (Sole paired maize,90-30-90 cm), T4(Sole groundnut TG-84), T5(Sole groundnut TG-37-A), T6 (Sole groundnut TG-88), T7 (Sole groundnut TG-89), T8 Alternate row of maize + groundnut TG- 84 (30 + 30 cm),T9 Paired row of maize + groundnut TG- 84 (75-45-75 cm maize in between 25-25 cm groundnut),T10 Paired row of maize + groundnut TG- 84 (90-30-90 cm maize in between 30-30 cm groundnut),T11 Alternate row of maize + groundnut TG- 37-A (30 + 30 cm) T12 Paired row of maize + groundnut TG- 37-A (75-45-75 cm maize in between 25-25 cm groundnut),T13 paired row of maize + Groundnut TG- 37-A (90-30-90 cm maize in between 30-30 cm groundnut),T14 Alternate rows of maize + Groundnut TG- 88 (30 + 30 cm),T15 Paired row of maize + groundnut TG- 88 (75-45-75 cm maize in between 25-25 cm groundnut), T16 Paired row of maize + groundnut TG- 88 (90-30-90 cm maize in between 30-30 cm groundnut), T17 Alternate rows of maize + groundnut TG- 89 (30 + 30 cm), T18 Paired row of maize + groundnut TG- 89 (75-45-75 cm maize in between 25-25 cm groundnut), T19 Paired row of maize+ groundnut TG- 89 (90-30-90 cm maize in between 30-30 cm groundnut). The two years of result revealed that intercropping increased the total N, P and K enhancing yield of both the crop. Total N,P and K uptake was recorded significantly higher with paired row of maize (75/45 cm spacing)in intercrop with groundnut variety TG-37 as compared to sole maize. In intercrop N,P and K uptake was recorded significantly higher in sole groundnut variety TG-37 followed by TG-84, TG-88 and TG-89.

Key words; Intercropping, Groundnut, Nutrient, Maize,groundnut,livelihood,intercropping,yield,farming inputs,maize producer

Introduction

Current global agriculture is under significant pressure due to the challenges of continuous population growth, the looming threat of climate change, reduction in available farmland and depletionof water resources. Additionally, evolving consumer demands contribute to the complex landscape faced by agriculture today (Hossain et al., 2021; Zaman et al., 2017; Maitra et al., 2018). In nations such as India, where a substantial proportion of farmers fall within the small and marginal categories, challenges abound. These include the year-round engagement of family labour, the imperative to produce an ample supply of nutritionally rich foods and the pursuit of livelihood enhancement. Given these circumstances, there is a recognized necessity to maximize productivity per unit area and optimize resource utilization. Intercropping emerges as a viable solution in this context, holding the potential to enhance both crop yield and farm income within a unit area, showcasing superior land use efficiency (Gitari et al., 2020). Additionally, intercropping is acknowledged for its reduced input requirements, specifically in terms of chemical fertilizers and pesticides, leading to the production of environmentally safe food in a sustainable manner (Maitra and Gitari, 2020; Duvvada and Maitra, 2020). intercropping is a traditional agricultural practice involving the simultaneous cultivation of two or more crops in the same field (Willey, 1979; Maitra, 2020). In essence, it can be affirmed that intercropping has the potential to contribute to poverty alleviation, hunger reduction and the provision of nutritious foods for smallscale farmers. In this context, maize (Zea mays L.) stands out as a particularly suitable choice, as highlighted in research findings (Panda et al., 2021). The primary goal of intercropping is to enhance productivity within a given land area and time frame by utilizing land resources and farming inputs, including labour, in an equitable and judicious manner. This is achieved without compromising the yield of the main crop, as emphasized by Marer et al.,2007. In maize-based cropping systems, incorporating legumes is considered a favourable alternative for enhancing nitrogen economy and increasing maize yield. Additionally, legumes contribute to bonus yield, heightened productivity per unit of time and space, and increased net returns compared to monoculture (Seran and Brintha, 2010). This is attributed to the differential rooting habits, varied growth patterns, resource demands, and complementary interactions facilitated by nitrogen fixation in legumes, which result in substantial organic biomass (leaves, nodules, roots, etc.). According to Kamanga et al. (2010), The observation in farmers' fields revealed that intercropping legume crops with maize resulted in the greatest quantity of vegetative biomass (Amos et al., 2012).Globally, maize is cultivated across an expanse of 193.7 million hectares, yielding a total production of 1147.7 million metric tonnes and achieving a productivity rate of 5.75 tonnes per hectare (FAO, 2020). Within the roster of maize-growing nations, India holds the 4th position in terms of cultivated area and the 7th position in terms of production (Anonymous, 2022). The United States stands as the leading maize producer, accounting for approximately 36% of the total production, which amounts to 30.2 million metric tonnes (DES, 2020).In the region of Jammu and Kashmir, maize is cultivated across an area spanning 0.31 million hectares, resulting in a production output of 0.51 million tonnes and a productivity rate of 1.65 tonnes per hectare. Introduction of groundnut in intercropping systems offers a better scope for maximizing and stabilizing the return from oilseed crop rather than as sole crop (Uddin et al., 2003). Groundnut cultivation under intercropping system is mostly by small and marginal farmers with traditional combinations involving 5 to 6 crops. The partitioning of limiting resources among crop species occurs whenever they are grown in association leading to intercrop advantage relative to monocropping in both grain or forage production (Eskandari and Ghanbari, 2009). Maize groundnut intercropping enhanced the efficient utilisation of strong light by maize and weak light by groundnut resulting in yield and nutrient uptake advantage. Intercropping also improves the quality and fertility of the soil through improving the enzymatic activities in the soil. Intercropping improves nutrient availability and uptake by plants and finally leads to boosts yield. Many studies indicated that intercropping have yield advantage over monocropping (Awal et al.,2006; Beedy et al., 2010). Increasing land use- water use efficiency (Choudary et al., 2016), improving land equivalent ratio (Yang et al., 2015) reducing fertilizer input (Yong et al.,2014). Therefore, intercropping provides an approach to achieve sustainable agriculture development. Nutrient uptake advantage of intercropping systems is due to both aboveground and underground interspecific interactions between intercropped species (Lie et al., 2006). Root interactions also play an important role in underground interspecific interactions (Xia et al., 2013). Considering the above facts that this experiment is planned to find out the nutrient uptake of maize as influenced by intercropping with different genotype of groundnut under temperate Kashmir valley.

Material and Methods

The study took place at the Faculty of Agriculture during the kharif season of 2021 and 2022 at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura, Sopore. The experimental soil exhibited silty clay loam characteristics with adequate drainage and normal levels of both reaction and salinity. Throughout the crop period, during 2021 the mean temperature varied between35.5°C and 6.7°C.During 2022 the mean temperature varied between 32.6°C and 4.6°C. The cumulative precipitation amounted during 2021was approximately 476.3 mm and during 2022 was 420.8 mm evenly distributed throughout the crop period. The levels of soil organic carbon and available NPK fell within the medium range.The experimental treatments comprised sole crops and various row proportions of maize intercropped with groundnut.The experimental design was randomized complete block design, consist nineteen treatments that were replicated three times. Treatment comprised of T1 (Sole maize, 60 cm), T2 (sole paired maize, 75-45-75 cm), T3 (Sole paired maize,90-30-90 cm), T4 (Sole groundnut TG-84), T5 (Sole groundnut TG-37-A), T6 (Sole groundnut TG-88), T7 (Sole groundnut TG-89), T8 Alternate row of maize + groundnut TG- 84 (30 + 30 cm),T9 Paired row of maize + groundnut TG- 84 (75-45-75 cm maize in between 25-25 cm groundnut),T10 Paired row of maize + groundnut TG- 84 (90-30-90 cm maize in between 30-30 cm groundnut), T11 Alternate row of maize + groundnut TG- 37-A (30 + 30 cm) T12 Paired row of maize + groundnut TG- 37-A (75-45-75 cm maize in between 25-25 cm groundnut), T13 paired row of maize + Groundnut TG- 37-A (90-30-90 cm maize in between 30-30 cm groundnut), T14 Alternate rows of maize + Groundnut TG- 88 (30 + 30 cm),T15 Paired row of maize + groundnut TG- 88 (75-45-75 cm maize in between 25-25 cm groundnut), T16 Paired row of maize + groundnut TG- 88 (90-30-90 cm maize in between 30-30 cm groundnut), T17 Alternate rows of maize + groundnut TG- 89 (30 + 30 cm), T18 Paired row of maize + groundnut TG- 89 (75-45-75 cm maize in between 25-25 cm groundnut), T19 Paired row of maize+ groundnut TG- 89 (90-30-90 cm maize in between 30-30 cm groundnut). Other management operations were carried out following the recommended package of practices for both the main and intercrops.During 2021and 2022 the crop was sown during 22nd and 21ststandard meteorological week (SMW) and harvest during 39th and 40th standard meteorologicalweek.Statistical comparisons were conducted for all the parameters among the treatments.

Result and Discussion

The uptake of nutrients by maize and intercrops was influenced by the specific combination and proportion in the intercropping system.Nutrient like Nitrogen, Phosphorus and Pottasium uptake of maize during both the year of 2021 and 2022 were recorded significantly higher with paired row of maize (75-45-75 cmspacing) intercrop with groundnut variety TG-37 (25-25 cm) as compared to sole maize, but paired row of maize (75-45-75 cmspacing)was at par with paired row of maize (90-30-90 cmspacing) intercrop with groundnut variety TG-89. In intercrop during 2021 and 2022 nutrient uptake was recorded significantly higher with sole groundnut variety TG-37 and lowest was with TG-89, within the intercrop highest nutrient uptake were recorded with paired row of groundnut intercrop with maize (90-30-90 cm spacing).This might be due to increased nutrient uptake could be attributed to the improved availability and supply of nitrogen provided by the leguminous crops intercropped with maize and the root system facilitates resource absorption and utilization (Zhang *et al*.,2017).In intercropping systems,the interspecific competitive use of nutrients regulates root spatial distribution to address the availability of soil nutrients (Yu*et al*., 2014; Yong *et al*.,2015). A well-developed fine root system and optimized root distribution can improve nutrient uptake by crops (Liu *et al*.,2020). The optimized root distribution helps to efficiently use the soil resource, and a higher root surface area increases the efficiency of acquiring nutrients. Nutrient absorption is increased in the in the maize-legume intercropping system compared to sole maize cultivation(Chalka and Nepalia2006).

Table: Nutrient uptake of maize as influenced by intercropping with different genotype of groundnut

	Maize Nutrient Uptake kg ha^{-1}							Intercrop Nutrient Uptake kg ha^{-1}					
	N		P		K		**Treatment**	N		P		K	
Treatment	2021	2022	2021	2022	2021	2022		2021	2022	2021	2022	2021	2022
MS(60cm)	88.9	92.5	34.7	35.8	160.20	164.27	TG84(30cm)	151.83	156.61	17.53	18.92	67.06	69.33
MS (75-45-75)	97.9	97.4	42.1	42.4	164.13	179.30	TG37(30cm)	166.59	170.55	18.97	19.53	71.98	73.85
MS(90-30-90)	94.5	95.4	40.9	39.5	175.10	165.29	TG88 (30cm)	151.94	151.59	17.65	18.07	66.74	67.45
M+TG84(1:1) 30cm	105.6	107.8	43.5	49.6	183.74	186.22	TG89(30cm)	145.07	153.74	17.04	17.63	66.21	69.52
M+TG84(2:2)25cm	114.2	113.8	48.8	50.6	188.04	187.79	M+TG84(1:1) 30cm	48.03	47.22	5.07	5.19	23.02	22.38
M+TG84(2:2)30cm	105.9	110.3	45.0	47.9	183.46	186.08	M+TG84(2:2)25cm	48.46	49.35	5.44	5.77	23.45	24.25
M+TG37(1:1)30cm	112.1	114.4	46.3	50.5	180.39	185.93	M+TG84(2:2)30cm	50.34	51.85	5.78	6.24	24.05	25.00
M+TG37(2:2)25cm	116.9	119.7	53.3	54.7	199.77	201.01	M+TG37(1:1)30cm	50.94	54.18	5.52	6.03	24.00	26.14
M+TG37(2:2)30cm	112.0	117.0	50.4	50.8	197.22	199.16	M+TG37(2:2)25cm	54.30	56.42	6.30	6.55	25.67	26.88
M+TG88(1:1)30cm	101.9	107.2	43.9	46.5	175.23	177.07	M+TG37(2:2)30cm	55.16	57.65	6.38	6.58	26.38	27.23
M+TG88(2:2)25cm	111.8	107.1	50.0	50.7	184.80	185.87	M+TG88(1:1)30cm	36.83	40.90	3.99	4.41	17.37	19.19
M+TG88(2:2)30cm	107.2	107.7	44.7	48.7	181.17	185.28	M+TG88(2:2)25cm	39.19	42.29	4.16	4.79	18.42	20.35
M+TG89(1:1)30cm	102.8	103.1	47.0	47.2	189.01	192.75	M+TG88(2:2)30cm	41.07	43.25	4.60	5.24	19.13	20.52
M+TG89(2:2)25cm	110.5	116.5	49.2	52.7	187.75	192.57	M+TG89(1:1)30cm	42.65	44.66	4.52	5.15	19.58	21.59
M+TG89(2:2)30cm	108.8	114.2	43.7	50.8	184.40	190.32	M+TG89(2:2)25cm	42.19	47.20	4.70	5.94	19.44	23.39
							M+TG 89(2:2)30cm	43.93	50.40	4.94	6.22	20.27	25.33
SEM (+)	4.0	2.9	3.1	1.8	4.83	4.85	SEM (+)	4.09	3.62	0.34	0.37	1.36	0.95

CD(p<0.05)	11.7	8.3	9.0	5.4	13.99	14.05	CD(p<0.05)	11.82	10.46	0.97	1.08	3.92	2.75

Conclusion

From the above findings it can be conclude that nutrient uptake was significantly higher with paired row of maize (75-45-75 cm spacing) in intercrop with groundnut variety TG-37 as compare to sole maize crop during both the year 2021 and 2022.

Acknowledgement

I owe to least one acknowledgement to SKUAST Wadura Campus Sopore, and my advisory committee for giving me opportunity to conduct trial at faculty of Agriculture

Reference

Amos RN, Jens BA and Symon M 2012. On-farm evaluation of yield and economic benefits of short-term maize legume intercropping systems under conservation agriculture in Malawi, Field Crops Research 132: 149-157.

Anonymous. 2022. Maize Statistics. ICAR- Indian Instutite of Maize Research. https://iimr.icar.gov.in

Awal M A, Koshi H and Ikeda T 2006. Radiation interception and use by maize/ peanut intercrop canopy. Agricultural and Forest Meteorology, 139: 74-83.

Beedy TL, Snapp SS, Akinnifesi FK and Sileshi GW 2010. Impact of GliricidiaSepium intercropping on soil organic matter fractions in a maized-based cropping system. Agriculture, Ecosystems and Environment 138: 139-146.

Chalka MK and Nepalia V 2006. Nutrient uptake appraisal of maize intercropped with legumes and associated weeds under the influence of weed control. Indian Journal of Agricultural Research 40(2): 86-91.

Choudhary VK, Dixit A and Chauhan 2016. Resource-use maximation through legume intercropping with maize in the eastern Himalayan region of India. Crop and Pasture Science 67: 508-519.

der Van W.Temporal niche differentiation increases the land equivalent ratio of annual intercrop : A meta-analysis. Field Crop Research 184: 133-144.

Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, 2020. Pocket Book of Agriculture Statistics.

Duvvada, S K and Maitra S 2020. Sorghum-based intercropping system for agricultural sustainability. Indian J. Nat. Sci., 10(60): 20306-20313.

Eskandari H and GhanbariA. 2009. Intercropping of maize (Zea mays L.) ans cowpea (Vigna sinensis) as whole-crop forage: Effect of different planting pattern on whole dry matter production and maize forage quality. NotulaeBotanicae Horti Agrobotanici Cluj-Napoca 37: 152–155

FAOSTAT, 2020. Food and Agriculture Organization of the United Nations, Rome, Italy. http: www.fao.org/faostat/en#data/QC

Gitari H I,NyawadeS O, Kamau S, Karanja NN, GacheneC KK, Raza M A, Maitra S and Schulte Geldermann E. 2020. Revisiting intercropping indices with respect to potato-legume intercropping systems. Field Crops Res., 258: 107957.

Hossain A, Skalicky M, BresticM, Maitra S, Alam M A, Syed M A, Hossain J, Sarkar S, Saha S, Bhadra P, Shankar T, Bhatt R, Chaki A K, Sabagh A E L and Islam T. 2021. Consequences and mitigation strategies of abiotic stresses in wheat (Triticum aestivum L.) under the changing climate. Agronomy, 11(2): 241.

Kamanga BC, Waddington GSR, Robertson MJ and Giller KE 2010. Risk analysis of maize-legume crop combinations with smallholder farmers varying in resource endowment in central Malawi. Journal of Experimental Agriculture 46: 1-21.

Li L, Sun J, Zhang F, Guo T, Bao X, Smith FA. Smith SE 2006. Root distribution and interaction between intercropped species. Oecologia 147: 280-290.

Liu XY, Sun HJ, Zhang FF and Li L 2020. The plasticity of root distribution and nitrogen uptake contributes to recovery of maize growth at late growth stages in wheat- Maize intercropping. Plant and Soil 447: 39-53.

Maitra S, Zaman A, MandalTK and Palai JB 2018. Green manures in agriculture: A review, J. Pharmaco. Phytochem., 7(5): 1319-1327

Maitra Sand Gitari, H.I. 2020. Scope for Adoption of Intercropping system in organic agriculture. Indian J. Nat. Sci., 11(63): 28624-28631.

Marer SB, Lingaraju, BS and Shashidhara GB 2007. Productivity and economics of maize and pigeon pea intercropping under rainfed condition in northern transitional zone of Karnataka. Karnataka Journal of Agricultural Sciences 20(1): 1-3.

Panda S K, Maitra S, Panda P, Shankar T, Pal A, Sairam M and Praharaj S 2021. Productivity and competitive ability of rabi maize and legumes intercropping system. Crop Res., 56(3-4): 98-104.

Seran T H and Brintha I 2010. Review on maize-based intercropping. Journal of Agronomy 9(3): 135-145.

Uddin S, Rahman, BagumJ, Md. Ara S2003. Performance of intercropping of maize with groundnut in saline area under rainfed condition. Pakistan journal of Biological Sciences. DOI: 10.3923/pjbs.2003.92.94.

Willey R W. 1979. Intercropping its importance and research needs. Part 1, Competition, and yield advantages. Field Crop Abstr., 32: 1–10.

Xia HY, Zhao JH, Sun HJ, Bao XG, Christie P, Zhang FS, Li L 2013. Dynamics of root length and distribution and shoot biomass of maize as affected by intercropping with different companion crops and phosphorous application rates. Field Crop Research 150: 52-62.

Yang Y, Stomph TJ, Makowski D, Werf Eskandari H., Ghanbari A. 2015. Intercropping of maize (Zea mays L.) ans cowpea (Vigna sinensis) as whole-crop forage: Effect of different planting pattern on whole dry matter production and maize forage quality. NotulaeBotanicae Horti Agrobotanici Cluj-Napoca 37: 152–155

Yong TW, Liu MX, Yang F, Song C, Wang CX, Liu WG, Su BY, Zhou L, Yang YW 2015. Characteristics of nitrogen uptake, use and transfer in a wheat-maize- soyabean relay intercropping systems. Plant protection Science 18: 388-397.

Yu P, White JP, Hochholdinger F, Li JC 2014.Phenotypic plasticity of the maize root system in response to heterogeneous nitrogen availability. Planta 240: 667-678.

Zaman A, Zaman P. and Maitra S. 2017. Water resource development and management for agricultural sustainability. J. Appl. Adv. Res., 2(2): 73-77.

Zang NY, Liu JM, Saiz G, Dannenmann M, Guo L, Tao YY, Shi CJ, Zuo Q, Butterbach K, Li YG, Lin S 2017. Enhancement of root systems improve productivity and sustainability in water saving ground cover rice production system. Field crop Research 213: 186-193.