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available K content, significantly lower than that of CK and N treatments; the highest soil-available K was observed with MNPK rather than NK. The application of NP or NPK also significantly increased the contents of these four parameters compared with applications of unbalanced fertilizers in winter wheat field.

The amount of light transmittance was significantly lower with MNPK treatment, while it was highest in CK and N treatments. With the NK and PK treatments, amount of light transmittance was similar but significantly lower than that of CK and N treatments ($P < 0.05$). With the NP and NPK treatments, light transmittance was significantly lower than that in unbalanced treatments, while it was relatively higher with treatments including organic manure under wheat field (Table 2).

3.2. Density and Species Composition of the Weed Communities

The long-term diverse fertilization treatments were greatly influenced the density of the weed communities (Figure 1). Weed density was substantially lower with balanced fertilizers treatments (NP, NPK and MNPK) compared with none (CK) or unbalanced fertilization (N, NK, PK) treatments in winter wheat field ($P < 0.05$). In contrast, total weed density was highest in the none (CK) or unbalanced fertilizers (N, NK, PK) treatments in winter wheat field (Figure 1).

Table 3 shows the differences in weed species that occurred with the various treatments. A total of 19 weed species from 10 families were also recorded in winter wheat field, of which six were perennial species, and other 13 species were annual (Table 3) in their life cycle. According to the functional group, the number of dicotyledonous weed species (15 spp.) was greater than that, of monocotyledonous (4 spp.). Asteraceae (4 spp.) was the most numerous family and followed by Brassicaceae, Poaceae and Euphorbiaceae were (3 spp.) respectively,

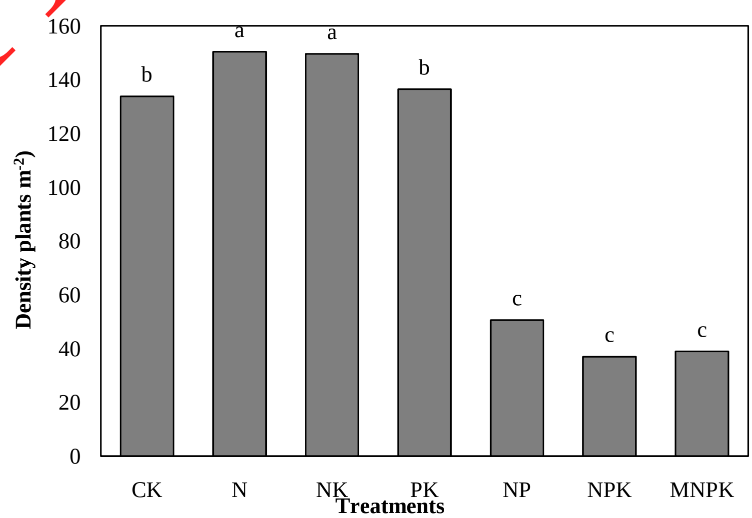

Figure 1. Density of weed communities (plants·m^{-2}) in different fertilizer management systems. Different lowercase letters on top of the bars represent significant difference between treatments at a 0.05 level (LSD test; $P < 0.05$).

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Table 3. Weed densities in different fertilizer treatments.

No.	Species name	Density (plants·m^{-2})						
		CK	N	NK	PK	NP	NPK	MNPK
1	*Acalypha australis Linn.*	21.4	9.2	16	16.4	12	5.6	14.2
2	*Avena fatua*	2	1.4	3.2	0.4	1.6	1.6	1.8
3	*Brassica rapa.*	1.6	4	3.6	0.2	0.6	0.2	1.8
4	*Calystegia hederacea*	14	28.4	39.2	3.2	9.2	5.2	7.6
5	*Chenopodium glaucum Linn.*	1	5.8	1.6	0	11.2	8	5
6	*Coronilla varia Linn.*	5.6	0	1.4	1.4	0	0	0
7	*Cirsium arvense*	9.8	6.4	8.4	5.4	1.8	0	0.2
8	*Cyperus rotundus Linn*	0	0	0	3.8	1.4	0	0
9	*Cynodon dactylon*	3.4	12.4	0	25	0	0	0
10	*Echinochloa crus-galli*	0	0	0	0	0.2	0	0
11	*Erigeron annuus*	6	2.2	4.2	4.2	0	0	0.2
12	*Erysimum cheiranthoides*	0	0	0	0	0.4	0.6	0
13	*Eschenbachia japonica*	4	5	6.8	6	0	2	0.6
14	*Euphorbia helioscopia*	0	0	0	0	0	0	0.2
15	*Euphorbia humifusa*	6.2	7	8.4	4.6	2	5.2	2
16	*Lathyrus latifolius*	0	0	5.6	4.8	0	3.8	0.4
17	*Lactuca serriola L.*	5.4	4.6	0	1.4	0	0	0
18	*Setaria viridis (Linn.)*	53.4	64	51.2	50.2	10.2	4.8	5
19	*Veronica persica*	0	0	0	9.4	0	0	0

and other Convolvalaceae, Compositae, Gramineae , Fabaceae, and Plantaginaceae were one species respectively, in studied period. Under the experiment, the following six weed species; (*i.e., Acalypha australis Linn, Avena fatua, Brassica rapa, Calystegia hederacea, Chenopodium glaucum Linn, Euphorbia humifusa* and *Setaria viridis Linn*) had found in various treatments, while other 13 weed species were found in some of the treatments. The weed community composition also varied with fertilization regime, the most dominant species was perennial dicots, particularly *Calystegia hederacea* and *Setaria viridis Linn*, its highest density observed under different fertilization treatments. The annual dicots weed species; *Cirsium arvense, Erigeron annus, Eschenbachia japonica* and *Setaria viridis Linn* were most dominant in low fertility such as CK, N, NK and PK treatments (Table 3). In contrast, the annual dicots weed species, *Chenopodium glaucum Linn* which was most dominant in high fertility such as NP, NPK and MNPK treatments.

The classification results of weed species on the basis of morphotype and life cycle demonstrated that the monocotyledonous annual weeds had the highest

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