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Research Article

Impact of temperature and soil moisture on paddy weed and productivity: A case of Lalitpur District, Nepal

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Abstract
Rice (*Oryza sativa L.)* is a major food crop for around 60% of the global population. The production of rice has been challenged by various biotic and abiotic factors. Temperature and soil moisture are the major abiotic and weeds are the major biotic factors for yield loss. The present experiment was conducted to investigate the impact of temperature and soil moisture on rice weed and rice productivity. The experiment was carried out under different temperatures (ambient, ambient +2^{0}C, and ambient +3^{0}C) and soil moisture (ambient, 25-30%, and 10-15%) conditions for the entire crop growth period from June to October 2014. Rice weeds were recorded after 28, 47 and 93 days of rice transplantation for varied soil moisture. Similarly, at varied temperature weeds were recorded after 19, 44 and 66 days of rice transplantation. The results showed that weed density increases under elevated temperature at 2^{0}C and 3^{0}C than under an ambient condition (existing in the surrounding area). An experiment on soil moisture stress indicates a reduction in rice productivity as the density of weed increases with the deficiency of soil moisture. Further studies on temperature and soil moisture resisting rice variety are essential. This study suggests that research on the control of weed species, targeting those weeds benefited at elevated temperature and soil moisture stress conditions, is necessary.

Keywords: Moisture, productivity, rice, temperature, weed

Introduction
Climate change has been a global issue, and its impact varies at local and regional scales. During the past three decades, the temperature rising pattern for the observed mean temperature ranges from 0.78 to 1.5°C, and it is predicted to be 2°C to 4°C at the end of this century (IPCC, 2014; Abbas et al., 2017; Bohari et al., 2017). There is an unfavorable change in precipitation patterns affecting different aspects of the environment (KC, 2017a). It has an impact on different sectors of the environment, including tourism (KC, 2017b; KC & Thapa Parajuli, 2015), water resources, agriculture (FAO, 2010), and a high-altitude ecosystem (KC & Ghimire, 2015). Agricultural productivity has been threatened by climate change (Ahmad et al., 2019) as it depends on climatic parameters like temperature, rainfall, and humidity. Precipitation and temperature are the major determining factor affecting rice production in changing climatic scenarios (Pheakdey et al., 2017). Similarly, under this changing climatic scenario, growth and competitiveness of weeds increases (Bir et al., 2018).

Rice (*Oryza sativa* L.) is a major staple food for around 60% of the global population (Bista, 2018). It is a crop grown from rainfed upland and lowlands to irrigated uplands ecosystems that consume a large amount of water (Choudhary & Suri, 2014; Kaur et al., 2015). Wherever irrigation is possible, people try to grow rice as a major food crop. Many families worldwide prefer to eat rice for lunch and dinner, making it one of the important crop varieties to grow. Production of rice was 501.2 million tons in 2016 (FAO, 2017) and 5.23 million metric tons in Nepal in same year (MoAD, 2017). In Nepal, rice is the primary foodstuff which occupies 42.5% of the total area under food grains and contributes about 51.6% of total grains production (ABPSD, 2016). Furthermore, rice solely contributes 20% of agricultural GDP (CDD, 2015) and provides more than 50% of the total calories of Nepalese (Kharel et al., 2018). Nevertheless, rice yield has been challenged by various biotic and abiotic environmental stressors.

There are different abiotic factors affecting rice productivity. The rice is a drought susceptible crop exhibiting serious deleterious effects when exposed to water stress (Bernier et al., 2008; Mishra et al., 2014), especially at the reproductive stage (Suriyan et al., 2010). The deficiency of water for irrigation is one of the most critical factors restricting the growth and generation of almost all the crops, including rice, and the intensity of this issue is aggravating over time (Ahmad et al., 2019; Passioura, 1996, 2007). Korres et al. (2017) reported that drought affects the phenol-morphological and physiological characteristics of rice diversely, resulting in productivity reductions, especially in

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rain-fed cropping systems. Particularly, stomata closure and the leaf CO_2/O_2 ratio get reduced, resulting in photosynthesis inhibition. In 2006, rice production was reduced by 30% in the Eastern region of Nepal due to drought (Malla, 2008). Additionally, decrease in rainfall negatively impact the summer rice crop when the farmers fully depend on rainfall for irrigation (Kharel et al., 2018; Regmi, 2007).

Rice yield is sensitive to climate change, particularly temperature (Schlenker & Roberts, 2009) and extended drought periods (Yoshida et al., 2015). Temperature is increasing at an average of 0.06° C per year (Bista et al., 2018), impacting soil moisture because of increased evapotranspiration. Rainy days are lessening at a rate of 0.8 days per year, leading to a delay in monsoon season and shortage of water, modifying cropping patterns and crop maturity duration (Regmi & Adhikari, 2007). Among various factors, biotic factors are also responsible for rice yield loss. Weed is the primary factor affecting grain yield. If it is not treated properly, it can cause entire crop loss (Dass et al., 2017). The quantity of yield loss varies by weed species, crop cultivar, farming practices, location, year, and weed infestation level (Abouziena & Haggag, 2016; Soltani et al., 2016). It is reported that the loss of productivity caused by weeds is larger than the losses resulting from pests or diseases and nitrogen deficiency (Rao et al., 2007). That is why weed control is one of the important aspects of increasing crop productivity.

There are different species of rice weed whose growth has been affected by several other factors. Increasing day and night temperature, carbon dioxide, and drought may influence dominant weed species, crop-weed competition, and weed management practices. It will further increase the weed problems and limit rice production (Rodenburg & Meinke, 2011; Ziska & Dukes, 2011). The growth response of crop and weed under elevated temperature also varies in their energy capture, e.g., C3 vs. C4 photosynthetic pathway (Korres et al., 2016, 2017). Weed-free condition at the beginning period of growth was found more vital than later stages for getting higher rice production (Thapa & Jha, 2001). Major rice limiting weed species in the case of Nepal are *Ageratum spp. (A. conyzoides and A. houstonianum), Alternanthera sessilis, Commelina benghalensis, Cyperus difformis, Cyperus iria, Digitaria ciliaris, Echinochloa colona, Echinochloa crusgalli, Fimbristylis miliacea, Marsilea quadrifolia, Monochoria vaginalis, Panicum repens, Polygonum hydropiper, and Sagittaria guayanensis* (MoAD, 2016). Due to crop weed competition, these weed species reduce the crop yield in transplanted rice by 15-40% (MoAD, 2016). A review paper on weed management in rice using crop competition reported that rice yield may reduce to 70-80% in Direct Seeded Rice and 50-60% in puddle transplanted rice under weedy conditions (Dass et al., 2017). Weed species in rice vary with temperature, soil type, altitude, latitude, seeding method, rice culture, weed control technology used, water management, and fertility level (Dorji et al., 2013). Weeds sometimes effectively compete, adapt, and tolerate stress more than crops to survive a wide range of environmental conditions (Korres et al., 2016).

Plenty of studies have existed on the impact of temperature and soil moisture on rice yield and weed density (Dass et al., 2017; Schlenker & Roberts, 2009; Yoshida et al., 2015). However, a detailed investigation of rice production, weed density, and variations under elevated temperature and soil moisture stressor has been limited. Changes in temperature and soil moisture threaten weed density, and paddy productivity varies in different regions. Hence, this study was conducted to understand the relationship between rice yields and weed density and frequency in Nepal under varied elevated temperatures and soil moisture.

Materials and Method

Study area description

The study was carried out in Bagmati Province, Godwari-11, Chapagaun, Lalitpur (16 km from Kathmandu, Nepal) (Fig. 1). It ranges in altitude from 1400 m to 1700 m from the mean sea level. Geographically, Chapagaun is located at 27^{0}57'81"- 27^{0}61'03" North latitude and 85^{0}31'32"- 85^{0}34'67" East longitude covering 6.71 square kilometers. The experimental site enjoys the sub-tropical type of weather conditions. Rice, maize, and millet are the major agricultural production (Chapagaun Village Profile and Situation Analysis, 2013). Climatic condition of study area is favorable for the rice production and limited study was carried out in this region.

Experimental details for temperature

The experiment was conducted in a temperature control chamber. The open-top chamber was constructed with the support of plastic sheets and bamboo, and temperature in the experimental plot was recorded thrice a day at the interval of six hours from July to October 2014. The thermometer was used for the measurement of temperature. In the case of an ambient temperature condition, the data of the Khumaltar station was used for the analysis. The temperature in the experimental chamber was recorded and maintained at the temperature of 2^{0}C and 3^{0}C higher than the ambient level. During the experimental period, the average ambient temperature of maximum (28.85, 28.40, 27.14, and 24.5^{0}C) and minimum (15.64, 20.60, 21.45, and 15.13^{0}C) was recorded from July to October 2014. The altitude of the site is about 1463 meters from sea level. Geographically, it is located at 27^{0}35'34.6" North latitude and 85^{0}19'32.2" East longitudes. Weeds were counted after 19, 44, and 66 days of paddy transplantation and identified. Paddy was grown at 0.27% Nitrogen, 215.3 kg/ha Phosphorous, 256.03 kg/ha Potassium, and 5.51% Organic matter, respectively, without applying inorganic fertilizer under rainfed condition. The local high yielding rice variety 'Khumal -4, Local Mangsuli' was considered as the experimental crop for the study. The experimental area was divided into 12 plots. There were three treatments (ambient, ambient +2⁰C, and ambient +3⁰C) and four replications. Each replicated plot size consisted of an area of 2 m× 2 m with a buffer of 0.5 m between adjacent plots. Water depth was maintained at 6 cm and plant spacing consisted of 7 cm x 6 cm (Fig. 2).

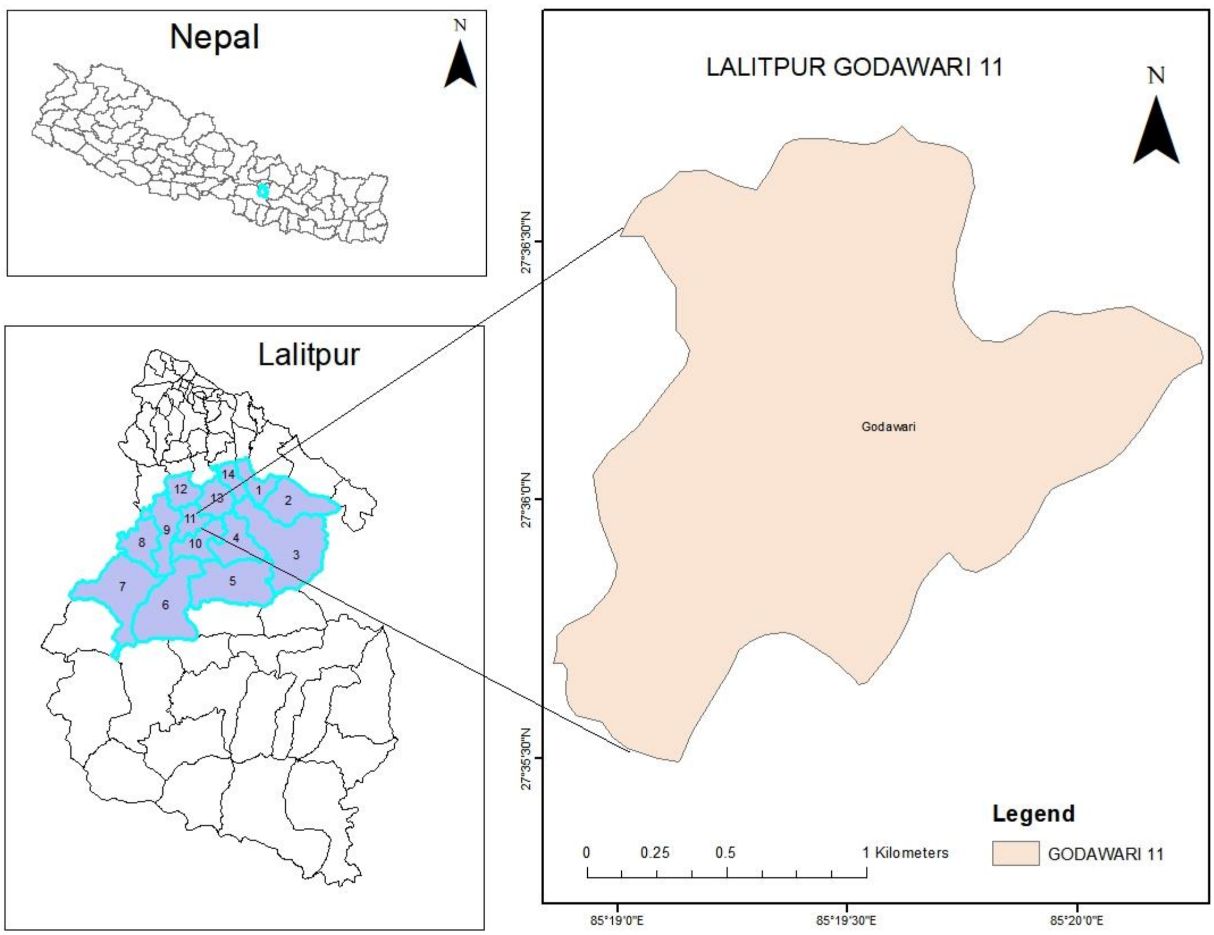

Figure 1 Map of the study area. Upper left map shows the location of Lalitpur district in Nepal map, lower left map shows the location of Godawari in Lalitpur district, and the right map shows Godawari-11, the study area.

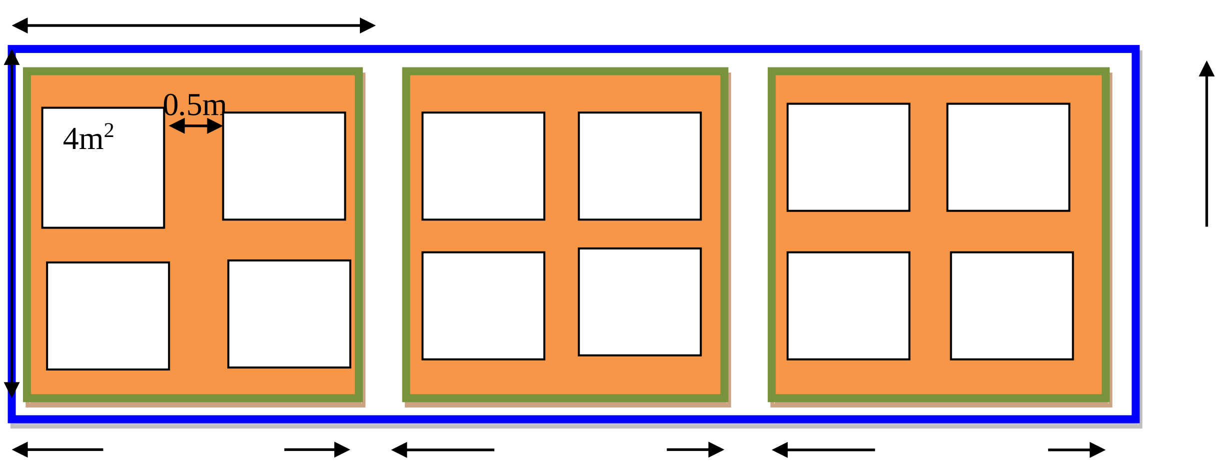

Figure 2 Field layout of the experiment site.

Treatment details for soil moisture
The experiment was conducted on the control chamber at Lalitpur, Chapagaun, from June to October 2014. The altitude of the site is about 1475 meters. Geographically, it is located at 27⁰35'48.7" North latitude and 85⁰19'27.9" East longitude. Similarly, during the period, the total rainfall received was 782.2 mm. Experiment was conducted on Nine experimental plots which consists of three treatments (ambient, 10-15% soil moisture, and 25-30% soil moisture) and three replications. Soil moisture in the chamber was recorded twice a day (before watering paddy) with the help of soil pH meter. Weeds were being counted after 28, 47, and 93 days of transplantation. Paddy was grown at 0.27% Nitrogen, 215.3kg/ha Phosphorus, 256.03kg/ha Potassium, and 5.51% Organic matter.

Grain yield measurement
After harvesting the crop, grain was dried, threshed, and again sundried. Grain moisture was measured using Wile 66 Moisture and Temperature Grain Meter available at Soil Science Division, National Agricultural Research Council. Rice yield was weighed at 10.1% grain moisture with the help of a digital weighing machine.

Data Analysis
Observed weeds were recorded from the experimental chamber, and further weed density and frequency were calculated. Collected data was refined and entered in Microsoft Excel. Further, the data were tabulated and presented in graphs.

Results and Discussion

Temperature and weed density
Altogether, 14 weed species (seven dicots and seven monocots) belonging to nine families were recorded in the transplanted paddy field. Dicot species and monocot species were equally present in the weed flora of the study area. Annual weeds with broadleaf species were the most observed species. Out of the total species, four C_4 and 10 C_3 weed species were recorded (Table 1). Weed density of most of the species showed a positive response with an increase in temperature. *Monochoria vaginalis, Polygonum hydropiper, Bidens pilosa*, *Dopatrium junceum, Digitaria* spp, *and Lindernia* spp *(L. anagallis and L. antipoda)* shows an increase in weed density up to 2^0C higher temperature. *Monochoria vaginalis* has the highest density at 2^0C higher temperature. It is an aquatic species that grows in wet to flooded conditions (Caton et al., 2010) and are favored by an increase in temperature (Bir et al., 2018). Regarding competition with crops, these species are moderately competitive with huge density at an early stage (MoAD, 2016). *Blyxa aubertii* has the highest density at both 3^0C higher temperature and the ambient condition. *Bidens pilosa* has the lowest density at both 3^0C higher temperature, and ambient condition (maximum average 27.22^0C), whereas *Echinochloa* spp has the lowest density at 2^0C temperature increase (Fig. 3). *Monochoria vaginalis and Cyperus iria* have the highest weed density at an ambient temperature condition. A similar result was observed by Rao et al. (2017) and MoAD (2016) in the paddy field.

After seven days of transplantation, weeds start to appear, and the highest weed density was recorded in September as the cropland was becoming dry and the crop was ready to ripe. Surface water in the paddy field was reducing the weed growth, as supported by the study of Manandhar et al. (2007). Weeds with a C_3 photosynthesis pathway (*Ageratum conyzoides*, *Blyxa aubertii*, *Monochoria vaginalis, Polygonum hydropiper*, *Bidens pilosa*, *Dopatrium junceum*, *Lindernia anagallis, and Lindernia antipoda)* were frequently recorded and have benefited from an elevated temperature. *Ageratum conyzoides*, *Monochoria vaginalis, and Digitaria* spp can cause a reduction in yield by 40%, 85%, and 70%, respectively (Kumar et al., 2017).

The density of weed at an ambient temperature condition was 25.9%. Similarly, at 3^0C rise in temperature, weed density was 33.8%, whereas, at 2^0C rise in temperature, weed density was 40% (Fig. 4). The highest weed density was recorded at an elevated temperature of 2^0C.

Temperature and weed frequency
Polygonum hydropiper has the highest frequency in all three temperature conditions showing that it occurs in a wide variety of habitats from flooded to damp areas. A similar result was observed by Caton et al. (2010). *Cyperus iria and Polygonum hydropiper* have a higher frequency at 2^0C elevated temperature. At 3^0C elevated temperature, *Polygonum hydropiper, Cyperus iria, Digitaria* spp*, Monochoria vaginalis, and Drymaria cordata* have the highest frequency (Fig. 5). *Digitaria* spp*, Polygonum hydropiper,* and *Commelina benghalensis* have the highest frequency in an ambient temperature condition. *Lindernia anagallis* and *Bidens pilosa* have the lowest frequency at both 2^0C elevated temperature and at an ambient condition whereas *Scleria biflora* and *Lindernia anagallis* have the lowest frequency at 3^0C elevated temperature.

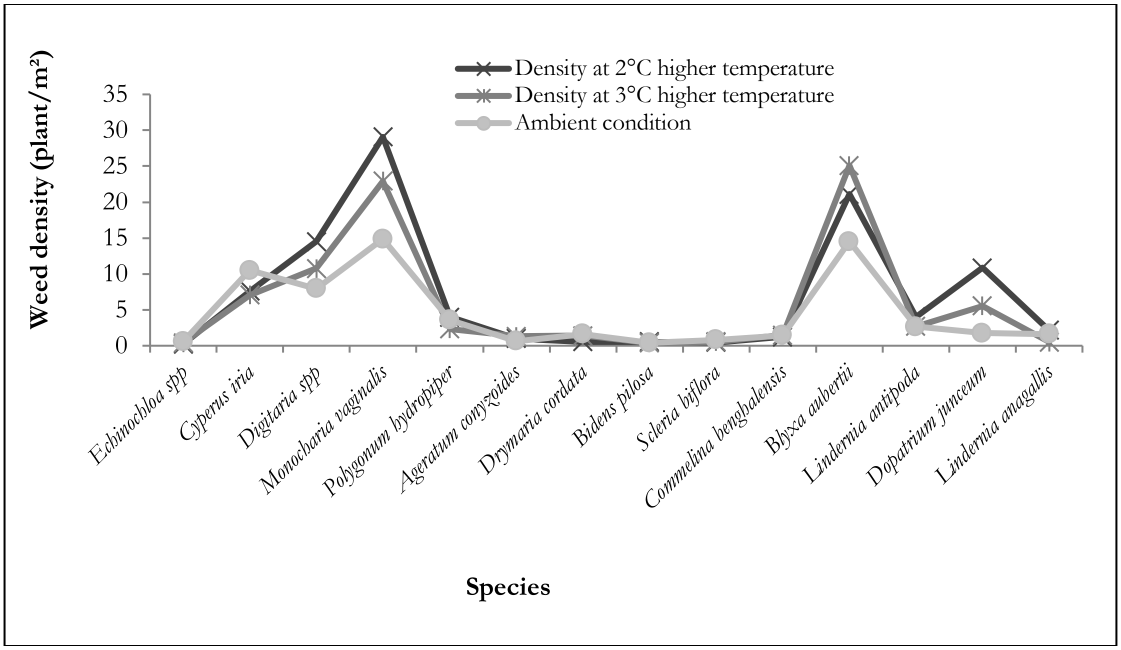

Figure 3 Density of weed species at varied temperature condition

Table 1 Floristic composition of rice weeds indicating their family

S.N.	Name of species at varied temperature	Life Cycle	Photosynthesis pathway	Local name	Family	Dicot/ Monocot
1	*Ageratum conyzoides*	*A/Broadleaf*	C_3	Gande	Asteraceae	Dicot
2	*Cyperus iria*	*A/Sedge*	C_4	Mothe	Cyperaceae	Monocot
3	*Drymaria cordata*	*A/Broadleaf*	C_3	Avijalo	Caryophyllaceae	Dicot
4	*Digitaria* spp	*A/Grass*	C_4	Banso	Poaceae	Monocot
5	*Echinochloa* spp	*A/Grass*	C_4	Sama	Poaceae	Monocot
6	*Dopatrium junceum*	*A/ Broadleaf*	C_3		Scrophulariaceae	Dicot
7	*Polygonum hydropiper*	*A/Broadleaf*	C_3	Pire	Polygonaceae	Dicot
8	*Lindernia antipoda*	*A/Broadleaf*	C_3		Scrophulariaceae	Dicot
9	*Scleria biflora*	*A/Sedges*	C_4		Cyperaceae	Monocot
10	*Bidens pilosa*	*A/Broadleaf*	C_3	Kalo Kuro, Kurkure	Asteraceae	Dicot
11	*Lindernia anagallis*	*A/ Broadleaf*	C_3		Scrophulariaceae	Dicot
12	*Monochoria vaginalis*	*P/Broadleaf*	C_3	Nilo Jaluke	Pontederiaceae	Monocot
13	*Commelina benghalensis*	*P/Broadleaf*	C_3	Kane Jhar	Commelinaceae	Monocot
14	*Blyxa aubertii*	*A/Broadleaf*	C_3		Hydrocharitaceae	Monocot

*A-Annual, P- Perennial
*Based on MoAD, 2016; Rao & Matsumoto, 2017; Caton et al., 2010

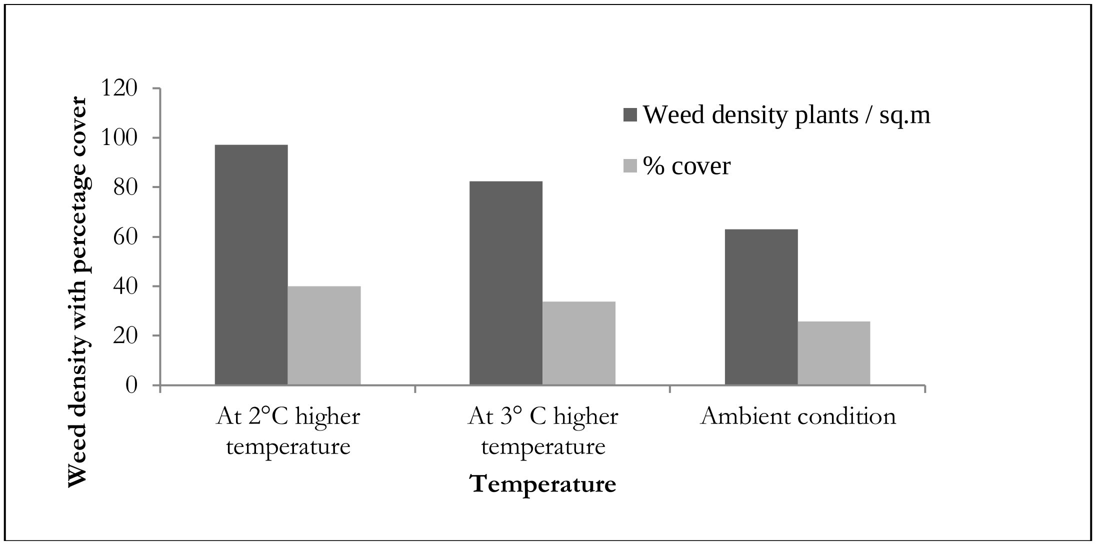

Figure 4 Overall weed density at varied temperature in experimental chamber with percentage cover

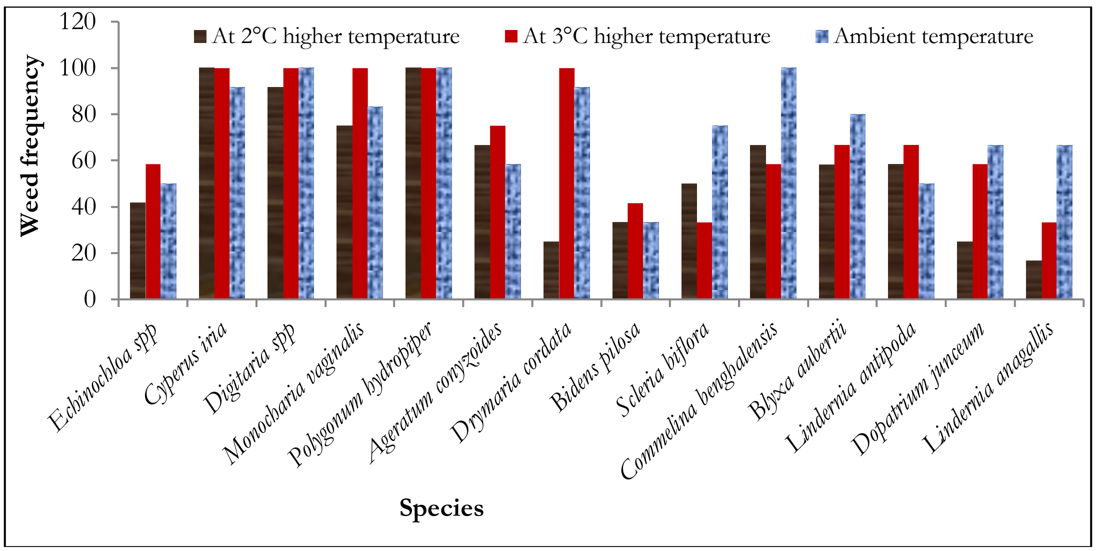

Figure 5 Weed frequency at varied temperature condition

Soil moisture and weed density

Altogether thirteen weed species (eight dicots and five monocots) belonging to seven families were recorded in the transplanted experimental paddy field of Chapagaun (Fig. 6). Soil moisture in the plot was maintained at 25-30% and 10-15% moisture. Dicots species were dominant in the weed flora of the study area. Annual weeds with broadleaf species were the most observed species, and four C_4 and 10 C_3 weed species were recorded (Table 2). Weeds with the C_3 photosynthesis pathway (*Ageratum conyzoides*, *Drymaria cordata*, *Bidens pilosa*, and *Lindernia nummularia)* were frequently recorded and have increased with the decrease in soil moisture. Weed density of *Ageratum conyzoides, Drymaria cordata*, *Digitaria* spp, *Lindernia nummularia,* and *Bidens pilosa* increased with the decrease in soil moisture. *Ageratum conyzoides, Cyperus iria,* and *Drymaria cordata* were highly observed species in all treatment conditions with the highest weed densities. In an ambient condition, *Cyperus iria* has the highest density as it grows in moist to wet soil (Kumar et al., 2017) whereas, in 25-30% soil moisture, *Stellaria media* has the highest density. At 10-15% soil moisture condition, *Ageratum conyzoides,* and *Drymaria cordata* have high density as it grows in moist shady places to dry (Kumar et al., 2017; MoAD, 2016). *Echinochloa* spp*, Lindernia antipoda, and Amischophacelus axillaris* have the lowest density in 10-15% soil moisture, 25-30% soil moisture, and the ambient condition, respectively (Fig. 6).

Table 2 Floristic composition of rice weeds indicating their family

S.No	Name of species at varied soil moisture	Life Cycle	Photosynthesis pathway	Common name/Local name	Family	Dicot/ Monocot
1	*Ageratum conyzoides*	*A/Broadleaf*	C_3	Gande	Asteraceae	Dicot
2	*Cyperus iria*	*A/sedge*	C_4	Mothe	Cyperaceae	Monocot
3	*Drymaria cordata*	*A/Broadleaf*	C_3	Avijalo	Caryophyllaceae	Dicot
4	*Digitaria* spp	*A/Grass*	C_4	Banso	Poaceae	Monocot
5	*Echinochloa spp*	*A/Grass*	C_4	Sama	Poaceae	Monocot
6	*Dopatrium junceum*	*A/ Broadleaf*	C_3		Scrophulariaceae	Dicot
7	*Stellaria media*	A/Broadleaf	C_3		Scrophulariaceae	Dicot
8	*Polygonum hydropiper*	*A/Broadleaf*	C_3	Pire	Polygonaceae	Dicot
9	*Lindernia antipoda*	*A/Broadleaf*	C_3		Scrophulariaceae	Dicot
10	*Amischophacelus axillaris*	P/Broadleaf	C_3		Commelinaceae	Monocot
11	*Scleria biflora*	*A/Sedges*	C_4		Cyperaceae	Monocot
12	*Lindernia nummularia*	*A/ Broadleaf*	C_3		Scrophulariaceae	Dicot
13	*Bidens pilosa*	*A/Broadleaf*	C_3		Asteraceae	Dicot

*A-Annual, P- Perennial
*Based on MoAD (2016); Rao & Matsumoto (2017); Caton et al. (2010)

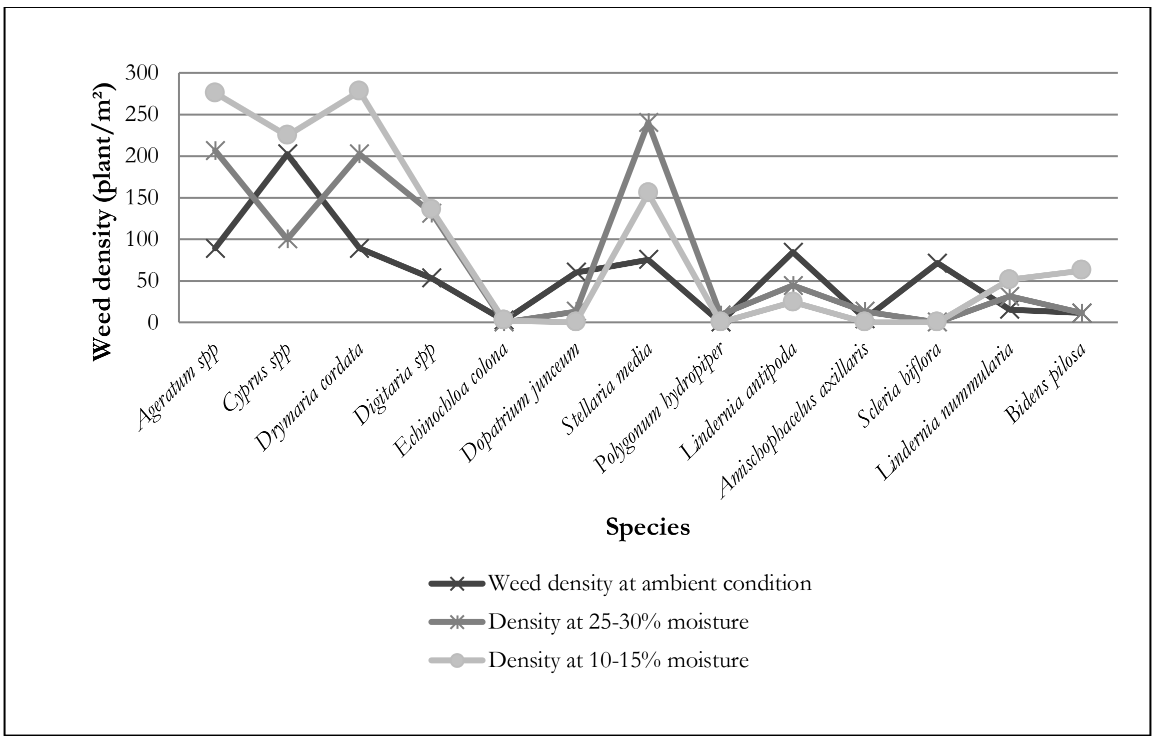

Figure 6 Weed density at varied soil moisture

The density of weed at ambient, 25-30% soil moisture, and 10-15% soil moisture was 25.5%, 33.7%, and 40.7%, respectively (Fig. 7). The highest weed density was recorded at 10-15% soil moisture condition. Moreover, weed height was maximum at 10-15% soil moisture and minimum at ambient conditions (Fig. 7). This shows weed density has been favored by the reduction in soil moisture in the experiment, similar to the finding of other researchers (Bir et al., 2018; Upasani & Baral, 2018; Ziska & Dukes, 2011). The genetic diversity of weed is greater and shows a stronger response with resource change, e.g., moisture, light, CO_2, and nutrients. (Bir et al., 2018; Upasani & Baral, 2018; Ziska & Dukes, 2011)

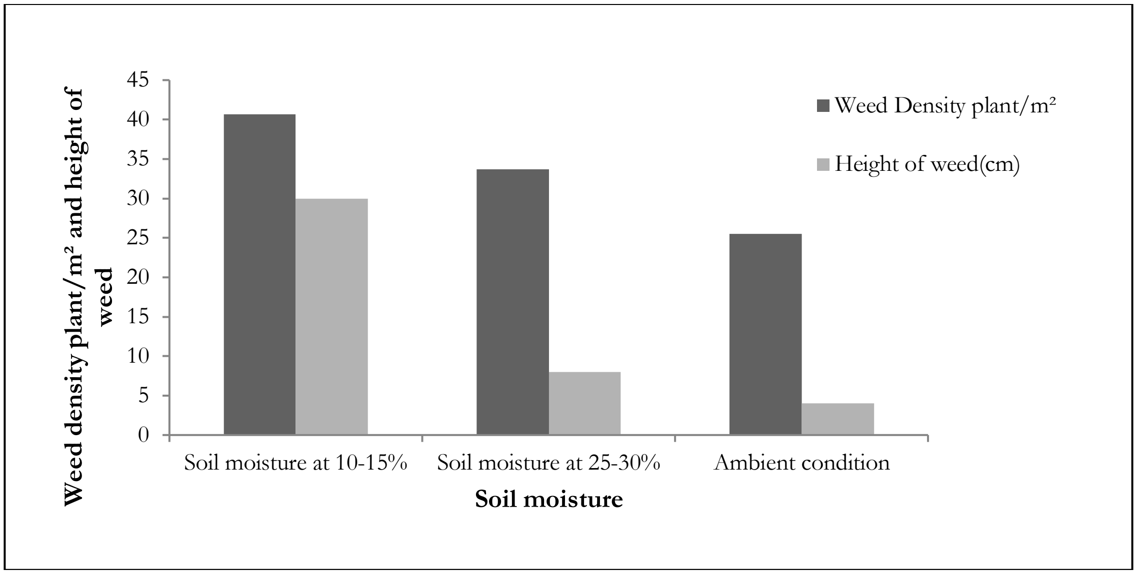

Figure 7 Height and Density of weed at varied soil moisture

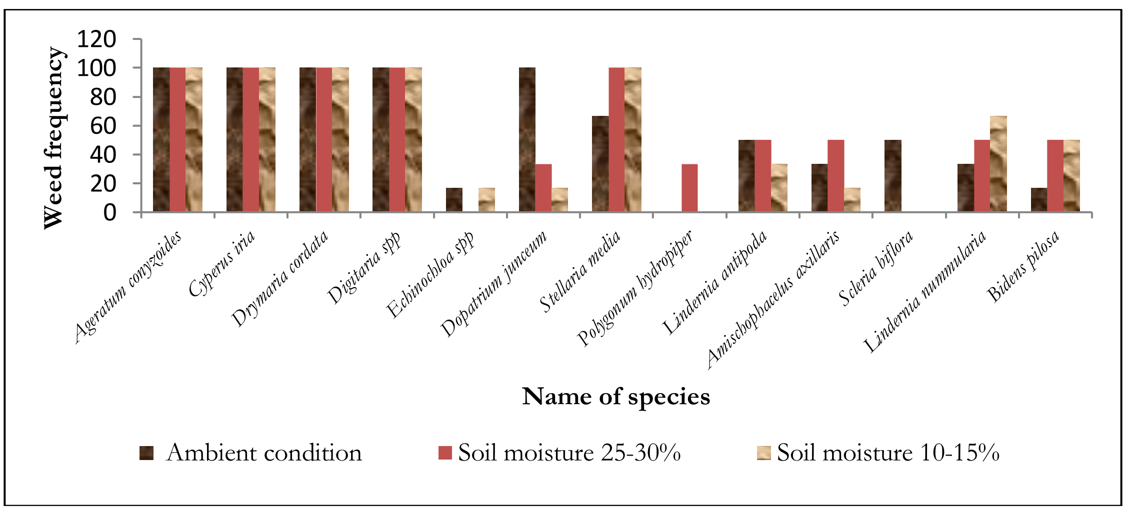

Figure 8 Weed frequency at varied soil moisture condition

Soil moisture and weed frequency

Ageratum conyzoides, Cyperus iria, Drymaria cordata, and Digitaria spp occurred at all the treatment conditions. At an ambient condition, *Ageratum conyzoides, Cyperus iria, Drymaria cordata, Digitaria* spp, *and Dopatrium junceum* have the highest weed frequency (Fig. 8). Whereas *Ageratum conyzoides, Cyperus iria, Drymaria cordata, Digitaria* spp, and *Stellaria media* have the highest frequency in 10-15% soil moisture and 25-30% soil moisture condition. *Echinochloa* spp has the lowest weed frequency at an ambient and 10-15% soil moisture conditions. *Polygonum hydropiper* has the lowest frequency in 25-30% soil moisture.

Relation among soil moisture, weeds density and grain yield

Grain yield was 16.66%, 27.77%, and 55.55% at 10-15%, 25-30% soil moisture, and ambient condition, respectively (Fig. 9). Furthermore, the weed density was maximum, and crop production was minimum at 10-15% soil moisture.

Generally, drought shortens the grain-filling duration but increases the remobilization of straw to the grains (Plaut et al., 2004). Reduction in rice yield at a moisture stress condition might be due to an increase in weed density. Higher moisture is decreasing weed density and increasing rice productivity. Under a moisture stress condition, the increased height of the weed is increasing competition between paddy and weed for the light. Rice production is limited by moisture stress (Bernier et al., 2008; Mishra et al., 2014), influencing the vegetative development rate and grain yield (Tao et al., 2006). Weed at an earlier period of crop growth (Thapa & Jha, 1999) and after transplantation reduces rice productivity (Dass et al., 2017).

In rice production, water stress at the booting stage (Pantuwan *et al*., 2002), flowering, and terminal period can disrupt floret initiation causing spikelet sterility and grain filling resulting in lower grain weight and eventually poor paddy generation (Botwright *et al*., 2008; Kamoshita *et al*., 2004). Okami et al. (2015) reported that the moisture stress during vegetative growth, before flowering, reduces productivity by reducing the growth of photosynthetic and storage organs, whereas soil moisture stress at the time of flowering might limit the viability of pollen, the receptivity of stigma, and the seed set (Barnabas et al., 2008).

It was reported that rainfall intensity in South Asian countries has increased, but the number of wet days has decreased (Lee et al., 2018; Navendrakumar, 2019). It might increase the soil moisture stress in the future, reducing the rice yield with the changing climate. Nepal is showing an increasing trend of annual mean rainfall, especially during June and July (Shrestha & Sthapit, 2015), whereas monsoonal precipitation is decreasing in Central Middle Mountain, Central Lowlands, and Eastern Lowland (Karki, 2017). In Nepal, approximately 40% of total agricultural land gets irrigation, and the rest of the land depends on the summer monsoon (MoEWRI, 2019). So, rice production is heavily dependent on rainfall. The present study showed that soil moisture is one of the most important abiotic factors affecting crop yield. Higher moisture stress lowers the crop yield due to sterile floret. It is necessary to provide a proper irrigation facility to maintain the soil moisture condition in the rice field to reduce weed density and increase rice productivity.

Despite the above findings, there are some limitations to this study. This experiment was conducted in a single rice variety, a specific site, and a specific time. Due to the lack of long time series observation, the statistical test such as correlation and significant test between temperature/ moisture and crop productivity were not observed. Data were obtained from the control experiment of one season.

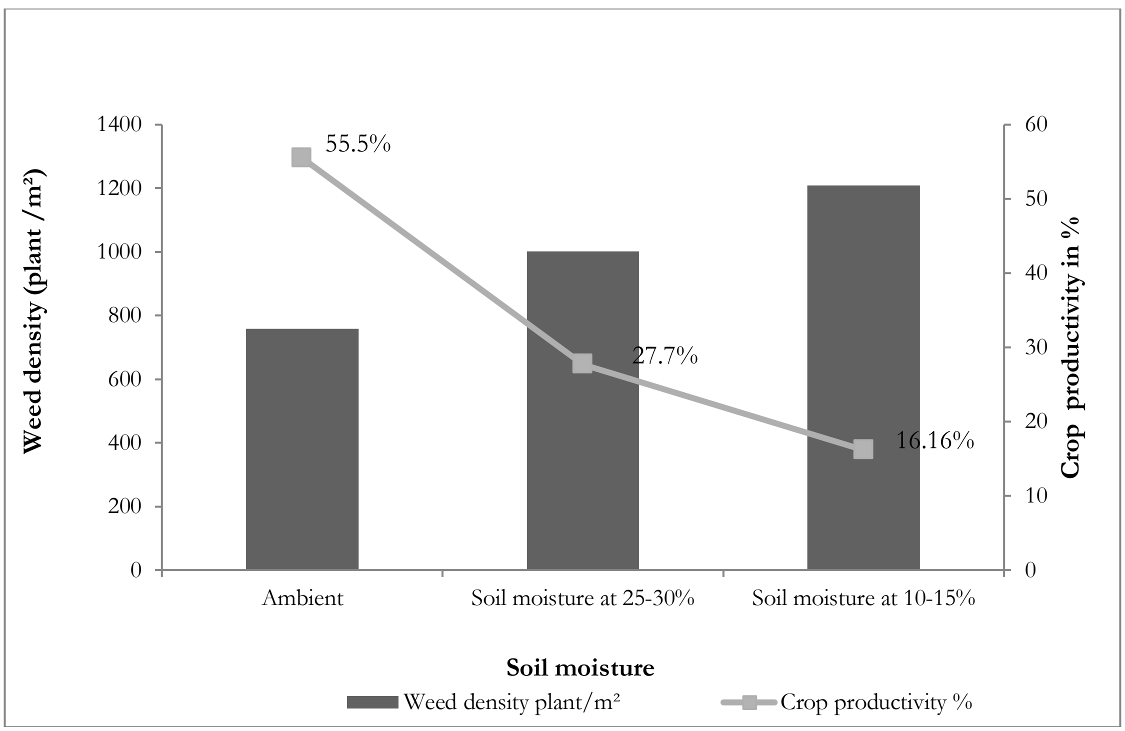

Figure 9 Weed density and crop productivity at varied soil moisture condition

Conclusion

We have investigated the impact of temperature and soil moisture on rice weed and productivity in control experiment. It has been concluded that the growth of both rice and weed species increased with the elevation of temperature. Annual weeds with the broadleaf species were the most observed species in the rice field under both experimental (temperature elevation and soil moisture stress) conditions. There is an increase in weed density and growth and decreased crop production under moisture-stressed conditions. Similarly increase in temperature is favorable for weed growth in paddy fields. The experiment showed moisture and temperature are key determinates for crop production and weed growth. This experiment suggests further study for the remedial measure of troublesome rice weed species. The experimental research can expand in multiple rice varieties in various conditions of temperature and soil moisture to test on rice productivity in the context of climate change.

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Author Contributions:
All four authors are involved in the analysis of the data and preparation of the paper. The first author and fourth author developed the concept of paper, but the first author conducted a detailed field study.

Conflict of Interest: The authors declare no conflict of interest.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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