Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 776-781

Received: 16-05-2020
Accepted: 18-06-2020

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Effect of seasons on carcass characteristics of broiler chicken under small scale production system

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Abstract
Carcass characteristics of commercial broiler chickens were studied in five agro-climatic zones of Assam during different seasons from March 2017 to February 2018. A total of 30 broiler farms with a minimum two hundred broilers (6 farms in each of 5 selected agro-climatic zones) were selected randomly. The birds were fed with *ad-libitum* commercial broiler feed and were reared under standard management condition. A total of twenty birds from each zone in each season were slaughtered at 42nd days of age to study the carcass characteristics**.** The results showed that higher dressing percentage during monsoon season (72.81±0.17) and lowest in winter season (70.15±0.21). The overall mean per cent yields of drumstick among different seasons did not differ significantly (P>0.05), however numerically higher per cent yield of drumsticks were recorded during monsoon season. Breast yield percentage was highest in winter (34.41±0.10) and lowest in monsoon (29.34±0.07) and intermediate in pre-monsoon and post-monsoon season. Significant differences (P≤0.05) in wings yield percentage were found among the seasons with lowest in winter season. The results also showed that overall mean per cent yield of giblet of broilers among different seasons did not differ significantly ((P>0.05).

Keywords: Broiler, carcass characteristics, drumsticks, giblet, season

Introduction
Protein from chicken meat and eggs is the cheapest source for human consumption. Broiler production is common in subtropical zones, particularly in Asian countries including India, where the poultry industry is expanding [1]. However, a wide range of seasonal variations greatly influences the productivity of broilers. Broilers exhibits optimal feed intake and weight gain when reared within the comfort zone. Poultry growth performance is not only inherited, but it is also greatly affected by the environment. In the modern broiler chicken production systems, genotype and environment are two main factors that affect output. Ample research has demonstrated that ambient temperature played an important part in broiler production since it affects the performance and causes economic problems [2-4]. Physiological stress can have deleterious effects on the overall performance and body growth of meat-type poultry [5] and this is still a challenging subject for poultry producers and academics. At present, climatic variation is a key threat for poultry industry, especially for marginal poultry farmers in open-house systems [6]. The environmental conditions during rearing of the broilers vary from season to season and have been known to affect the carcass characteristics of broiler. Therefore, present study was conducted to determine the influence of the season on carcass characteristics of broiler.

Materials and Methods
The study was conducted in all five agro-climatic zones *viz.* Upper Brahmaputra Valley Zone (Z_1), Hill Plateau (Z_2), North Bank Plain Zone (Z_3), Central Brahmaputra Valley Zone (Z_4) and Lower Brahmaputra Valley Zone (Z_5) of Assam during pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November) and winter (December to February) seasons from March 2017 to February 2018. Six broiler farms were selected randomly from each of the zones, thus a total of 30 broiler farms with a capacity of 200 birds were used for the above study. The birds (Cobb 400) were fed *ad-libitum* with commercial broiler starter and finisher feed and were reared under standard management condition up to the age of 42 days.

At 42 days, five birds from each zone in each season were randomly selected for carcass quality traits. The live weight of each bird was recorded by digital weighing balance and then slaughtered as per standard methods. The birds were scalded, de-feathered and studied for carcass characteristics after singeing, washing and de-feathering. The weights of the different organs and cut-up parts were also recorded with the help of digital weighing balance after cutting the organs as per standard procedures.

Dressing percentage

Processing (slaughtering, bleeding, scalding and de-feathering) of the birds was carried out with standard procedure. The dressed weight of carcass was calculated after bleeding, de-feathering, removal of head, shanks, tip of wings and oil glands, evisceration and giblet removal and expressed on the basis of pre-slaughtered live weight percentage.

$$\text{Dressing percentage (\%)} = \frac{\text{Dressed wt. (live wt. after bleeding, de-feathering, evisceration and giblet removal)}}{\text{Pre-slaughter live weight}} \times 100$$

Cut up yield (%)

Eviscerated yield was recorded excluding the giblet and was expressed in terms of percentage.

$$\text{Eviscerated yield (\%)} = \frac{\text{Weight of eviscerated carcass - Giblet weight}}{\text{Pre slaughter live weight (g)}} \text{ X } 100$$

Per cent yields of cut-up parts were calculated on eviscerated weight basis.

$$\text{Cut up yield (\%)} = \frac{\text{Weight of individual part(g)}}{\text{Eviscerated weight (g)}} \text{ x } 100$$

Giblet yield

The gall bladder was detached from liver, heart was freed from pericardium, internal clots and adhering vessels and gizzard were cleaned by removing the inner lining and faecal material. The weight of heart, liver and gizzard was recorded as giblet yield (g) and expressed in terms of percentage.

$$\text{Giblet yield (\%)} = \frac{\text{Weight of Giblet (g)}}{\text{Pre slaughter live weight (g)}} \text{ X } 100$$

Statistical analysis

The data so collected were tabulated and analyzed by using [7] as per standard statistical methods [8] and expressed in mean±SE. Duncan Multiple Range test of SPSS was performed for mean statistical significant difference.

Results and Discussion

Pre-slaughter live weight: The overall mean pre-slaughter live weights of broiler chicken at 42nd day of age recorded as 2606.12±13.38, 2376.00±15.34, 2560.24±14.24 and 2740.32±15.93g respectively during pre-monsoon, monsoon, post-monsoon and winter seasons as presented in Table1. The results indicated that pre-slaughter live weight of broilers differed significantly ($P \leq 0.05$) among different seasons, wherein significantly ($P \leq 0.05$) higher pre-slaughter live weight was found during winter followed by pre-monsoon, post-monsoon and monsoon seasons. However, the corresponding values were comparable between pre-monsoon and post-monsoon seasons. Contrary to the present findings, [9] reported that seasons did not influence the pre-slaughter live weights in free range indigenous chicken. The pre-slaughter live weights of broiler chicken differed numerically among different agro-climatic condition of Assam.

Dressed weight

The results of mean dressed weights of broiler chicken at 42nd day of age during different seasons under different agro-climatic conditions of Assam are presented in Table 1. The results showed that the overall mean dressed weights during pre-monsoon, monsoon, post-monsoon and winter seasons were 1855.90±11.00, 1730.01±11.03, 1818.81±13.82 and 1922.39±5.09g, respectively. The statistical analysis showed that the dressed weights of broilers among different seasons differed significantly, wherein significantly ($P \leq 0.05$) higher dressed weights were recorded during winter followed by pre-monsoon, post monsoon and monsoon seasons. There was no significant difference between the values during pre-monsoon and post-monsoon seasons.

Dressing percentage: The mean dressing percentage (%) of broiler chicken at 42nd day of age, during pre-monsoon, monsoon, post-monsoon and winter seasons was found as 71.21±0.21, 72.81±0.17, 71.04±0.19 and 70.15±0.21, respectively. The statistical analysis showed that the dressing percentage of broilers among different seasons differ significantly ($P \leq 0.05$), wherein significantly ($P \leq 0.05$) highest dressing percentage was observed during monsoon season followed by pre-monsoon and post monsoon seasons and lowest in winter season. However, no significant differences ($P > 0.05$) in dressing percentage was found between pre-monsoon and post monsoon seasons. The significantly ($P \leq 0.05$) higher dressing percentage in the present study during monsoon as compared to winter season might be due to low de-feathering loss (6.22% and 8.71%) and lower liver weight (56.38 g and 69.38 g) (Table 3) during monsoon and winter season, respectively. [10] also recorded higher feather loss during winter than that of summer resulted in lower Newyork dressed weight in winter. Further, winter raised birds had longer intestine and caeca, heavier and thicker proventriculus than the bird raised on summer [11] which may also result higher dressing percentage during monsoon season. These findings corroborated well with the observations of [10], who recorded significantly lower dressing percentage in winter as compared to summer season. Contrary to the results of the present findings [12] found no effect on carcass yield due to seasons. Similarly [13], observed no significant ($P > 0.05$) differences in dressing percentage of broilers raised during fall and summer. Further [14], also found higher dressing percentage in rainy season followed by winter and summer ($P < 0.05$) [9]. Also reported no significant differences of pre-slaughter live weights in different seasons of indigenous chicken under free range system.

Cut up parts: The mean cut-up part yields (g) and per cent yield (on DWB) of different cut- up parts of broilers in different seasons under different agro-climatic zones are presented in Table 2.

Drumsticks: The overall mean per cent drumstick yields recorded as 15.31±0.11, 16.08±0.10, 15.93±0.10 and 15.74±0.15, respectively during pre-monsoon, monsoon, post-monsoon and winter seasons (Table 2). The results showed that the mean per cent yields of drumstick among different seasons did not differ significantly ($P > 0.05$), however numerically higher per cent yield of drumsticks were recorded

during monsoon season [9]. reported that mean per cent drumstick yields were comparatively higher during post-monsoon than other seasons, but the values did not differ significantly ($P \leq 0.05$) in different seasons in case of indigenous cock under free range system. They also found that, drumstick yields were significantly ($P \leq 0.05$) higher during post-monsoon than pre-monsoon season in indigenous hen. Lower values of drumstick yield than the present findings reported as 10.08±0.13 [15] and 10.19±0.08 [16], which might be due to genetic makeup, size of the bird and management condition.

Thighs: The overall mean per cent yields of thigh during pre-monsoon, monsoon, post-monsoon and winter seasons were 15.65±0.09, 16.38±0.11, 16.39±0.07 and 15.84±0.09, respectively (Table 2). The study also showed that there was no significant difference ($P>0.05$) in mean corresponding values of thigh yields of broilers among different seasons. Similarly, [17, 9] also reported that season had no significant effect on thigh yields in indigenous chicken.

Breast: At 42nd day of age, the mean per cent yield of breast during pre-monsoon, monsoon, post-monsoon and winter seasons was 31.61±0.12, 29.34±0.07, 31.68±0.12 and 34.41±0.10 respectively. The statistical analysis showed that the mean per cent yield of breast of broilers among different seasons differed significantly ($P \leq 0.05$) with highest breast yield percentage during winter season followed by pre-monsoon and post monsoon and lowest in monsoon season. No significant differences ($P>0.05$) in breast yield percentage were found between pre-monsoon and post monsoon seasons. The results of the present study were in the line of the observation of [18] who recorded that broilers reared at 34 ˚C exhibited a significant decrease in breast yield compared to the broilers reared at 22 ˚C. Similar findings were also reported by [19, 20].

Back: The overall mean per cent back yields of broiler chicken recorded during pre-monsoon, monsoon, post-monsoon and winter seasons were 18.29±0.12, 18.42±0.13, 17.47±0.09 and 16.47±0.13 respectively (Table 3). The present values were comparable with the corresponding values observed by [9] in indigenous chicken. The statistical analysis showed that the mean per cent yield of back of broilers among different seasons did not differ significantly ($P>0.05$), however numerically highest mean value recorded during monsoon season. The present findings corroborated the findings of [17, 9], who also reported that back yields were not influenced by the seasons in indigenous chicken in their respective studies.

Wings: At 42nd day of age, the overall mean per cent yields of wings during pre-monsoon, monsoon, post-monsoon and winter seasons was 11.92±0.10, 12.76±0.09, 11.61±0.06 and 10.55±0.11 respectively in broiler chicken. Significant differences ($P \leq 0.05$) in wings yield percentage were observed among various seasons with lowest in winter season [21]. Also noticed significantly low ($P \leq 0.05$) weight of wings (6.98 ± 0.83) in birds reared under EC chamber facility at 24 ^{0}C with 60% RH compared to birds reared 33 ^{0}C with 60% RH. Contrary to the present findings [9], reported that mean values recorded in indigenous cock were numerically higher in post-monsoon than other seasons but they did not differ significantly ($P \leq 0.05$) in different seasons, however in hen; the wing yields were significantly higher in post-monsoon than pre-monsoon season. The corresponding values recorded in post-monsoon were also comparable to monsoon and winter seasons in indigenous hen under free range scavenged system.

Neck: At 42nd day of age, the mean per cent yields of neck during pre-monsoon, monsoon, post-monsoon and winter seasons were 6.76±0.14, 6.82±0.07, 6.73±0.05 and 6.86±0.06 respectively in broilers (Table 3). No significant differences ($P>0.05$) in neck yield percentage were found among various seasons. The present findings were in accordance with the results of [9], who also reported that neck yields were not influenced by season.

Giblet Yields: The mean giblet yields (g) and per cent yield (on Pre slaughter live weight basis) of giblet of broilers in different seasons under different agro-climatic zones are presented in Table 3. At 42nd day of age, the mean per cent yield of giblet during pre-monsoon, monsoon, post-monsoon and winter seasons was 3.64±0.06, 3.86±0.05, 3.67±0.05 and 3.82±0.04 respectively. The statistical analysis showed that the mean per cent yield of giblet of broilers among different seasons did not differ significantly (($P>0.05$). However, numerically higher giblet per cent yield was found in monsoon season. The findings of the present study were corroborated the observation of [10] who also found higher giblet weight during summer than winter.

Liver: At 42nd day of age, the mean per cent yield of liver during pre-monsoon, monsoon, post-monsoon and winter seasons was 2.34±0.01, 2.38±0.03, 2.34±0.01 and 2.53±0.02, respectively (Table 3). The statistical analysis showed that the mean per cent yield of liver of broilers among different seasons did not differ significantly ($P>0.05$), however higher per cent yield of liver was recorded during winter seasons. These findings supported the observations of [22, 23] who recorded increased liver weight in birds exposed to low environmental temperature. [11] found significantly heavier liver weight (% body weight) in winter than that of summer season [21]. also noticed significantly higher ($P<0.05$) weight of liver as percentage of body weight in birds reared under EC Chamber facility at 24 ^{0}C with 60% RH compared to birds reared 33 ^{0}C with 60% RH.

Heart: At 42nd day of age, the mean per cent yield of heart during pre-monsoon, monsoon, post-monsoon and winter seasons was 0.43±0.02, 0.43±0.02, 0.41±0.03 and 0.45±0.05, respectively (Table 3). The statistical analysis showed no significant differences ($P>0.05$) in mean per cent yield of heart of broilers among different seasons, wherein numerically higher mean per cent heart yields was observed during winter season. These findings were similar with the observations of [22, 23] who recorded increased heart weight in broilers exposed to low environmental temperature. In the present study, the higher heart weight in winter season might be due to increased in energy requirement during winter season due to low environmental temperature which resulted necessary changes in the cardiovascular system to accommodate the energy needs. However [24], also reported comparatively higher heart weight during dry season than rainy season in scavenged indigenous chicken.

Gizzard: Table 3 depicts that overall mean per cent yield of gizzard during pre-monsoon, monsoon, post-monsoon and winter seasons was 0.86±0.01, 0.92±0.01, 0.87±0.12 and 0.85±0.03 respectively. The results indicated that the mean per cent yield of gizzard of broilers among different seasons did not differ significantly (P>0.05), although the values were numerically differed from each other [9]. reported that giblet yields (%) both in indigenous cock and hen were significantly (P≤0.05) higher during monsoon season than post-monsoon and winter seasons, however the mean values were comparable between pre-monsoon and monsoon season and also between post-monsoon and winter season [24]. also reported comparatively higher gizzard weight during dry season than rainy season in indigenous chicken.

Table 1: Season wise mean carcass characteristics of broiler chicken in different agro-climatic zones

Traits	Seasons	Agro-climatic zones					Season average
		Z_1	Z_2	Z_3	Z_4	Z_5	
P re-slaughter live weight (g)	Pre-monsoon	2605.80^{Aa}	2594.60^{Aa}	2602.20^{Aa}	2623.20^{Aa}	2604.80^{Aa}	2606.12^{A}
	Monsoon	2352.40^{Ba}	2338.80^{Ba}	2335.60^{Ba}	2408.00^{Ba}	2445.20^{Ba}	2376.00^{B}
	Post-monsoon	2553.00^{Aa}	2549.20^{Aa}	2571.80^{Aa}	2562.40^{Aa}	2564.80^{Aa}	2560.24^{A}
	Winter	2748.00^{Ca}	2725.00^{Ca}	2733.60^{Ca}	2732.8^{Ca}	2762.20^{Ca}	2740.32^{C}
DF weight (g)	Pre-monsoon	2415.60	2404.80	2409.40	2417.60	2412.80	2412.04
	Monsoon	2201.00	2192.40	2188.20	2263.60	2295.80	2228.20
	Post-monsoon	2363.00	2359.20	2380.40	2371.60	2375.40	2369.92
	Winter	2516.00	2484.20	2496.00	2492.40	2519.60	2501.64
DF loss (%)	Pre-monsoon	7.31	7.31	7.41	7.83	7.38	7.45
	Monsoon	6.44	6.25	6.32	5.98	6.12	6.22
	Post-monsoon	7.44	7.45	7.44	7.45	7.39	7.43
	Winter	8.44	8.82	8.68	8.80	8.79	8.71
Dressed weight (g)	Pre-monsoon	1864.47^{Aa}	1845.70^{Aa}	1855.47^{Aa}	1863.16^{Aa}	1850.73^{Aa}	1855.90^{A}
	Monsoon	1708.98^{Ba}	1706.89^{Ba}	1701.14^{Ba}	1757.22^{Ba}	1775.81^{Ba}	1730.0^{B}
	Post-monsoon	1814.60^{Aa}	1812.69^{Aa}	1825.32^{Aa}	1816.73^{Aa}	1824.72^{Aa}	1818.81^{A}
	Winter	1920.01^{Ca}	1918.00^{Ca}	1915.99^{Ca}	1913.24^{Ca}	1944.69^{Ca}	1922.39^{C}
Dressing %	Pre-monsoon	71.55^{Aa}	71.14^{Aa}	71.30^{Aa}	71.02^{Aa}	71.05^{Aa}	71.21^{A}
	Monsoon	72.65^{Ba}	72.98^{Ba}	72.83^{Ba}	72.97^{Ba}	72.63^{Ba}	72.81^{B}
	Post-monsoon	71.08^{Aa}	71.11^{Aa}	70.97^{Aa}	70.90^{Aa}	71.14^{Aa}	71.04^{A}
	Winter	69.87^{Ca}	70.39^{Ca}	70.08^{Ca}	70.01^{Ca}	70.40^{Ca}	70.15^{C}

Means bearing different capital letters among rows within a column and different small letters within a row among column differ significantly (P≤0.05)

Table 2: Season wise mean cut-up part yields (%) of broiler chicken in different agro-climatic zones

Traits	Seasons	Agro-climatic zones					Season average
		Z_1	Z_2	Z_3	Z_4	Z_5	
Drum-stick	Pre-monsoon	15.13^{a}	14.90^{a}	15.37^{a}	15.40^{a}	15.75^{a}	15.31^{A}
	Monsoon	16.19^{a}	15.65^{a}	16.04^{a}	16.47^{a}	16.05^{a}	16.08^{A}
	Post-monsoon	15.73^{a}	16.00^{a}	16.03^{a}	15.81^{a}	16.04^{a}	15.93^{A}
	Winter	15.71^{a}	15.74^{a}	15.73^{a}	15.72^{a}	15.78^{a}	15.74^{A}
Thigh	Pre-monsoon	15.80^{a}	15.62^{a}	15.33^{a}	15.70^{a}	15.81^{a}	15.65^{A}
	Monsoon	16.42^{a}	16.32^{a}	16.50^{a}	16.35^{a}	16.34^{a}	16.38^{A}
	Post-monsoon	16.24^{a}	16.40^{a}	16.45^{a}	16.55^{a}	16.28^{a}	16.39^{A}
	Winter	15.69^{a}	15.96^{a}	15.66^{a}	16.24^{a}	15.66^{a}	15.84^{A}
Breast	Pre-monsoon	30.85^{a}	31.95^{a}	31.64^{a}	31.89^{a}	31.69^{a}	31.61^{A}
	Monsoon	29.12^{a}	29.70^{a}	29.36^{a}	29.15^{a}	29.36^{a}	29.34^{B}
	Post-monsoon	31.47^{a}	31.66^{a}	32.07^{a}	31.56^{a}	31.63^{a}	31.68^{A}
	Winter	34.39^{a}	34.35^{a}	34.17^{a}	34.27^{a}	34.86^{a}	34.41^{C}
Back	Pre-monsoon	18.86^{a}	18.68^{a}	18.18^{a}	17.85^{a}	17.84^{a}	18.29^{A}
	Monsoon	18.43^{a}	18.71^{a}	18.44^{a}	18.18^{a}	18.36^{a}	18.42^{A}
	Post-monsoon	18.00^{a}	17.35^{a}	17.07^{a}	17.43^{a}	17.49^{a}	17.47^{A}
	Winter	16.69^{a}	16.34^{a}	16.55^{a}	16.48^{a}	16.28^{a}	16.47^{A}
Wings	Pre-monsoon	11.80^{a}	11.68^{a}	12.30^{a}	12.02^{a}	11.81^{a}	11.92^{AB}
	Monsoon	12.49^{a}	12.77^{a}	12.85^{a}	12.83^{a}	12.85^{a}	12.76^{B}
	Post-monsoon	11.45^{a}	11.77^{a}	11.54^{a}	11.58^{a}	11.70^{a}	11.61^{AB}
	Winter	10.49^{a}	10.39^{a}	10.67^{a}	10.55^{a}	10.66^{a}	10.55^{B}
Neck	Pre-monsoon	6.56^{a}	6.83^{a}	6.81^{a}	6.86^{a}	6.75^{a}	6.76^{A}
	Monsoon	6.87^{a}	6.76^{a}	6.65^{a}	6.87^{a}	6.94^{a}	6.82^{A}
	Post-monsoon	6.79^{a}	6.66^{a}	6.74^{a}	6.72^{a}	6.73^{a}	6.73^{A}
	Winter	6.86^{a}	7.09^{a}	7.08^{a}	6.60^{a}	6.64^{a}	6.86^{A}

Means bearing different capital letters among rows within a column and different small letters with in a row among column differ significantly (P≤0.05)

Table 3: Season wise mean giblet yields (%) of broiler chicken in different agro-climatic zones

Traits	Seasons	Agro-climatic zones					Season average
		Z_1	Z_2	Z_3	Z_4	Z_5	
Giblet	Pre-monsoon	3.67[a]	3.65[a]	3.63[a]	3.64[a]	3.59[a]	3.64[A]
	Monsoon	3.71[a]	3.75[a]	3.80[a]	3.65[a]	3.72[a]	3.73[A]
	Post-monsoon	3.62[a]	3.88[a]	3.62[a]	3.63[a]	3.61[a]	3.67[A]
	Winter	3.85[a]	3.86[a]	3.82[a]	3.78[a]	3.85[a]	3.83[A]
Liver	Pre-monsoon	2.33[a]	2.35[a]	2.33[a]	23.37[a]	2.33[a]	2.34[A]
	Monsoon	2.40[a]	2.41[a]	2.42[a]	2.30[a]	2.36[a]	2.38[A]
	Post-monsoon	2.33[a]	2.34[a]	2.34[a]	2.35[a]	2.33[a]	2.34[A]
	Winter	2.57[a]	2.54[a]	2.52[a]	2.48[a]	2.55[a]	2.53[A]
Heart	Pre-monsoon	0.45[a]	0.43[a]	0.43[a]	0.41[a]	0.41[a]	0.43[A]
	Monsoon	0.42[a]	0.41[a]	0.43[a]	0.45[a]	0.45[a]	0.43[A]
	Post-monsoon	0.41[a]	0.42[a]	0.41[a]	0.42[a]	0.41[a]	0.41[A]
	Winter	0.44[a]	0.45[a]	0.46[a]	0.44[a]	0.45[a]	0.45[A]
Gizzard	Pre-monsoon	0.88[a]	0.87[a]	0.87[a]	0.86[a]	0.85[a]	0.86[A]
	Monsoon	0.89[a]	0.93[a]	0.95[a]	0.90[a]	0.91[a]	0.92[A]
	Post-monsoon	0.87[a]	0.88[a]	0.87[a]	0.87[a]	0.87[a]	0.87[A]
	Winter	0.84[a]	0.87[a]	0.84[a]	0.86[a]	0.85[a]	0.85[A]

Means bearing different capital letters among rows within a column and different small letters with in a row among column differ significantly ($P \leq 0.05$)

Conclusion

The present study indicated that season had significant effect on dressing percentage and highest dressing percentage was obtained during monsoon season. However most of the cut-up parts yields *viz*. drumsticks, thigh, back, neck *etc*. were not influenced by season. Similarly the giblet yields were also not influences by season. However, further in-depth research is needed to validate the present findings.

Acknowledgements

The authors express their thankfulness to the farmers, who sincerely record the data during entire study. They also express their gratitude to the Director of Research (Vety.), Assam Agricultural University for providing necessary support and cooperation during the study.

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